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ABSTRACT

Taken from a December 1976, conference sponsored by the Bureau of International Labor Affairs, these proceedings present research reports on the impact of international trade and investment on U.S. employment. The research, produced or in some instances contracted and monitored by the Department of Labor, is intended to be of use to economists and policymakers. Generally, introductory remarks precede each session part and comments and replies follow the paper's presentation. In the first of seven parts, a sample of industry studies is concerned with the steel and auto industries. Proceedings in part 2 involve labor market adjustments and the issue of displacement. Part 3 introduces a paper evaluating direct labor market effects of the old trade adjustment assistance program before its reformulation under the 1974 Trade Act. The fourth part examines foreign investment and employment. In part 5 a paper is presented on international productivity comparisons. Part 6 is concerned with the effect of the U.S. tariff policy on trade and employment. The final part examines issues for research and policy and the value of research on policy making. (CSS)

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The Impact of International Trade and Investment on Employment

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A Conference on the Department
of Labor Research Results

U.S. Department of Labor
Ray Marshall, Secretary

Bureau of International Labor Affairs
1978

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U.S. DEPARTMENT OF HEALTH,
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Preface

Times and circumstances change; a new Administration takes office; new principles and goals emerge. The papers in this volume were designed about two to four years ago, and delivered more than a year ago. They have been brought together and published in this volume to fulfill commitments made at that time.

Howard D. Samuel
Deputy Under Secretary for
International Affairs

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Editors' Introduction

William G. Dewald, Harry Gilman, Harry Grubert, and Larry Wipf

- Do imports cost the U.S. economy jobs and contribute to unemployment?
- Do foreign investment and the export of U.S. technology take tools from U.S. workers and reduce their comparative ability to produce?
- Do workers who lose their jobs because of international trade have a harder time getting other jobs or get worse ones than other displaced workers?

Yes and no answers to such questions have been easy to come by over the years. Yet what is needed to implement U.S. international economic policy is not just a yes or no answer. What is needed is an answer that estimates how large effects are and how long it takes them to occur as a consequence of a change in international economic policy. What would happen to trade flows, prices, output, and employment in the industry directly affected? What would be the indirect effects in the rest of the economy? How long would it take for the adjustments to occur? And by how much would the various interests involved be affected?

It is surprising, considering how politically important these issues have become, that little systematic investigation of such questions existed until the inauguration of the Department of Labor research program on Employment Effects of International Trade and Investment. Though the Department of Labor research program is comparatively new, having been started as recently as 1973, it has already had considerable influence in directing the attention of research economists to the serious issues that are involved. The program as it was conceived and as it has been managed intends not to advocate particular positions with respect to free trade or for that matter particular labor or business interests. The intent was for dispassionate, scientific analysis of the important issues that were involved. Information, not opinion, was the objective. It is not clear that the program has been uniformly successful in this regard. But it is clear that an enormous quantity of information has been accumulated, only part of which is presented in this conference volume. Such information has been useful to policy makers with regard to issues as diverse as multilateral trade negotiations, quotas on imports of particular commodities, and the administration of the trade adjustment assistance program. Thus the program has gained the attention not only of professional economists, but also of policy makers.

The major part of the research program was designed to assist in the continuing interagency review of international trade policy. One area of active policy review that is highlighted in the conference is the U.S. position in the current round of multilateral trade negotiations. Issues of major concern include the selection of a tariff cutting formula, the development of a list of products that will be excepted from tariff cuts, negotiation of reductions in nontariff barriers to trade, safeguard mechanisms to smooth adjustments, and general reform of the General Agreement on Tariffs and Trade (GATT) itself.

The Department of Labor research program naturally is focused particularly on labor dislocation costs that might be expected to follow cutbacks of employment in an industry. These costs include both the duration of unemployment after layoff and any reduction of wages in the subsequent job. Knowledge about these costs is important not only for decisions about changes in trade policy but also in the area of direct foreign investment and technology transfer. Aspects of the labor adjustment process that are of interest include:

- How dislocation costs differ from one industry to another.
- How dislocation costs depend on such characteristics of workers as age, job tenure, skill level, and location.
- Whether reductions in employment occur through natural attrition or actual displacement.

Another area of research involves estimating the impact of direct foreign investment by U.S. companies on U.S. trade, the distribution of wages and employment, the rate of investment, and so on. A related area is the effect of transfers of U.S. technology on the long-term pattern of U.S. trade and the status of U.S. workers. One aspect of this problem involves the analysis of the principal channels for technology transfer whether by sale or licensing.

In addition to providing essential information for trade negotiations and analysis of legislative proposals affecting trade and investment, the Department of Labor's International Trade and Employment Research Program deals directly with problems associated with the trade adjustment assistance program, which is administered by the Bureau of International Labor Affairs. The objective of this research is to identify workers who are genuinely impacted by international trade, to determine how much TAA payments compensate workers for their pecuniary losses as well as to explore alternatives to trade adjustment assistance.

As noted, the Bureau of International Labor Affairs has been conducting research on these and related issues for several years. It operates with a small staff of economists in the Department of Labor. The staff is involved directly in research and in monitoring a contract research program. On December 2 and 3, 1976, the Department of Labor sponsored a conference to present a sample of results of this research program on the impact of international trade and investment on U.S. employment. Papers in the conference were all based on research contracts at least partly funded by the Bureau of International Labor Affairs. The studies had necessarily been recently completed or in a few cases were close to completion at the time of the conference.

The main objective of the conference was to examine critically these research studies and to make the results available to a wide audience of economists and policymakers in and out of government. This volume presents the main proceedings of the conference. It is organized into sections that more or less follow the organization of the conference. First is the brief presentation by Joel Segall who, at the time of the conference, was the Deputy Undersecretary for International Affairs in the Department of Labor. The remainder of the volume is organized in 7 parts corresponding to sessions at the conference. Following the research papers in each section are comments on particular papers by formal discussants. Authors of the papers in some instances have prepared replies to these criticisms.

In Part 1, a sample of industry studies is presented covering the steel and auto industries. These studies were prepared by research teams at the Public Research Institute of the Center for Naval Analyses and Charles River Associates respectively. The studies involve very detailed econometric estimates of supply and demand conditions in the industries and the output and employment effects of changes in import competition. Other industries that have been studied under the auspices of the Office of Foreign Economic Research include oil, shoes, sugar, electronics, chemicals, and trucks, among others.

Part 2 of the volume involves labor markets directly. Two Public Research Institute studies are presented. One is concerned with the dynamics of the labor market adjustment process, the other is concerned with estimation of the earnings losses incurred by individuals displaced from selected manufacturing industries.

In Part 3 there is a paper based on a research report evaluating the old trade adjustment assistance program before its reformulation under the 1974 trade act. Also included is a speech by Murray Finley. Though his presentation was made at a luncheon session at the conference, Murray Finley's remarks are published under the trade adjustment assistance heading. As president of the Amalgamated Clothing and Textile Workers, he provided numerous illustrations of problems that the trade adjustment assistance program has had in meeting its objectives.

Part 4 involves foreign investment and employment. The papers by Thomas Horst and by Richard Freeman and Robert Frank utilized widely different research methodologies that yielded largely contradictory results. Horst found limited employment effects of foreign investment whereas, though Freeman and Frank found little total job effect, they identified the possibility of substantial wage losses to U.S. workers as a consequence of foreign investment. This possibility was developed in another way by Jack Baranson who described in detail recent cases of technology transfer from the United States.

Part 5 presents a paper by Laurits Christensen, Dale Jorgenson, and Dianne Cummings on international productivity comparisons. It was based on their well-known factor productivity methodology. They identified saving as an important source of high productivity gains in Japan and Germany which in this respect have outperformed many of the other countries studied including the United States.

Part 6 is concerned with U.S. tariff policy. The papers in the session reported quite detailed industry estimates of the international trade and employment effects of changes in tariffs. The study by Robert Baldwin and Wayne Lewis examined the employment effects in over 350 industries including the indirect effects on the suppliers to those industries. William Cline's study considered interactions of trade flows with the rest of the world, as well as employment effects that might be expected to result, depending on which tariff cutting formulas were applied. The Wharton Econometric Forecasting Associates research, which was summarized by Lawrence Klein, presented results of the Wharton Industry Model as modified to incorporate international trade. The papers generally found fairly small aggregative employment effects as a consequence of lowering tariffs but in many cases identified large effects in particular industries.

Part 7 includes comments by Michael Moskow, who at the time of the conference was the Undersecretary of the Department of Labor, and a panel discussion on the issue of what is the value of the Department of Labor research results for policy making. The panel consisted of Robert Baldwin, representing the economic research community, and government policy makers Clayton Yeutter, who was then Deputy Special Trade Representative, and Harold Lamar, an economist from the Staff of the House Ways and Means Committee. The panel also includes a brief comment by Elizabeth Jager of the AFL-CIO, who is one of the strongest critics not only of international economic policy making as it relates to the labor movement, but also of the kind of economic research that was presented at the conference.

As organizers of the conference and editors of the conference volume we wish to thank the many individuals who made it all possible.

- Joel Segall, whose idea it was to develop this line of research on international trade and employment.
- The professional staff in the Department of Labor, the Employment and Training Administration, (formerly the Manpower Administration) and other agencies of government who have cooperated so splendidly not only financially, but also in the evaluation of research proposals and monitoring research in progress.
- The economic researchers who took what often amounted to book-length research reports and rewrote them as conference papers, sometimes with the heavy application of the editors' blue pencils.
- The formal discussants who offered their considerable expertise in evaluating the conference papers candidly and professionally. Among these very distinguished economists, it may be appropriate to single out Harry G. Johnson, University of Chicago and the Graduate Institute of International Studies, Geneva, who participated in the conference despite his not having fully recovered from an earlier stroke. Harry Johnson's presence made the conference official in a certain sense. He was one of the most published international economists in history. Though his bent was highly theoretical, he continually strived to bring economic analysis to the attention of practical policy makers. He was an inveterate conference organizer and participant. Professor Johnson died in Geneva on May 8, 1977, at age 53.
- Earnestine Barnes and Kaye Sykes who provided excellent secretarial services at the Office of Foreign Economic Research in Washington.
- Ronald H. Smith who took major responsibility in organizing the physical arrangements for the conference at the Mayflower Hotel in Washington, December 2 and 3, 1976.
- Richard Mathews who designed the volume from cover to cover and William Kusterbeck who organized its printing.
- The editor's colleagues at Ohio State University, Jeanette White, who coordinated the complex correspondence and manuscript preparation that was entailed, and Lynne Wakefield who copyedited the manuscripts and prepared the index.

Finally, our gratitude goes to the hundreds of conference participants, not only those from various government and research offices in Washington, but many from around the country. Their presence at the conference made it a lively and interesting affair befitting the enormous importance of the issues that were under consideration. All in all it was a most successful conference. We hope that the conference proceedings give some sense of this to an even wider audience.

Introduction to the Conference

Joel Segall

About four years ago the Department of Labor began a program of research on the relationship between the economic conditions of U.S. workers and international economic forces. At that time, the Hartke-Burke bill was under consideration by the Congress, the administration had started to draft its own version of trade legislation, there had been an important change in the structure of international exchange systems, and the patterns of trade and foreign investment were shifting rapidly. In all these matters, the Department of Labor was becoming increasingly involved. The impact on U.S. employment and employment conditions was a central issue and debates on employment effects were frequent, intense, and unconstrained by reference to a common base of empirical knowledge and understanding.

1. Issues

The questions that lacked — and probably still lack — persuasive answers are embarrassing in their significance for policy. A partial list would include the following:

Trade Negotiations

It seems clear that the United States will gain, on balance, from freer trade. But the gains from trade are *net* gains, the difference between the gains to some groups in the economy and the losses to others. Sensible policy formulation requires knowledge, in quantitative terms and in disaggregated form, about

- Who gains from expanded trade, who loses, and how much?
- Where do the U.S. interests lie in the current multilateral trade negotiations? What tariff formula would serve us best? What industries should be excepted from the negotiations?

Adjustment to Changing Trade Patterns

When the patterns of trade change, for whatever reason, the costs of adjusting tend to fall on specific groups of workers in the import-competitive industries. The process and cost of such adjustment have never been well studied and, as a consequence, we know too little about workers unemployed as a result of imports. For these workers, we must know such things as:

- How long does it take to find another job? What will the new wages be?
- To what extent do the adjustment costs depend on the specific industries involved and local labor market conditions?
- Are workers displaced because of imports different from workers displaced for other reasons?

Foreign Investment

An area of almost unrelieved ignorance has involved the relationship between U.S. investment abroad and U.S. employment. A central issue is whether U.S. investment abroad replaces U.S. domestic investment or other countries' investments. If U.S. foreign investment replaces domestic investment, U.S. jobs and real wages may be adversely affected. The problem is difficult because it poses the counterfactual question: what would have happened if the U.S. investment abroad had not taken place? Would a firm from a different country have made the investment? If so, the impact on U.S. employment is small. It is probably no accident that in the past, estimates of the employment impact of U.S. foreign investment have ranged from a job loss of over a million to a job gain of over half a million, and sometimes in the same study. Policy makers ought to know:

- What would have been the effect on domestic employment, productivity, and terms of trade if U.S. investments abroad had not been made?

- Should we be concerned about the transfers of technology that frequently accompany U.S. investment abroad? What role does the transfer of technology play in raising foreign productivity and what implications are there for U.S. production and employment?

The inventory of unanswered questions could be extended, of course, and many of the questions, as stated, conceal deeper, more complex questions. But in view of the little that is known about the effect of trade and investment on U.S. employment, it is not surprising that discussions in this area commonly take on an air of academic unreality. The Department of Labor research program was initiated to induce competent, professional researchers to study these important policy-related problems that they had, in the main, ignored for so long. The more specific goals were to assist the Department of Labor in arriving at policy positions on foreign trade and investment issues and to make a start in accumulating a body of empirical evidence that could serve to inform public discussion.

The program is now old enough to make the results public and to begin arriving at some judgment on the program's value. That is why the conference was held and why this volume is being published. The papers in this volume are summaries, of course, since most of the original commissioned works ran to several hundred pages each. A serious effort was made to insure that the papers could be readily understood by noneconomists. That effort was not always successful and extra study may be required for some items. The papers do not constitute the entire research program. Rather, they were selected to provide coverage of the topics likely to be of general interest at a large conference.

The primary, and perhaps the only, justification for government funded research is that it helps policy makers make policy. Accordingly, it may be useful to touch on what these papers offer policy makers in the areas specified above.

2. Papers

Trade Negotiations

The papers in this area generally conclude that very substantial reductions in trade barriers can be achieved with significant gains to consumers and with little or no adverse impact on aggregate employment. This finding applies to nontariff as well as to tariff barriers and to Canada, Japan, the European Economic Community, and some other countries, as well as to the United States. Alternative tariff-cutting formulas are evaluated for their coincidence with the interests of the United States and its major trading partners.

One of the papers (Baldwin and Lewis) offers unusually detailed estimates of trade and employment effects in the U.S. by industry, region, and occupational groups. These disaggregated findings are not particularly striking in that the import-sensitive industries are already well known and that one would expect multilateral tariff cuts to increase the demand in the United States for farmers while decreasing the demand for semiskilled workers. Yet, the modest magnitude of these impacts in total *is* striking and especially so in view of the assumptions that tend to bias results in the direction of exaggerating the adverse impacts.

The very broad papers just described are supplemented by two intensive industry studies on steel and motor vehicles. The steel study suggests that the complete removal of trade barriers during the period 1969–73 would have had a significant but gradual impact on the U.S. steel industry and that some, but not many, layoffs would have resulted. The auto study estimates the sensitivity of the U.S. share of the automobile market to changes in import price and tariffs. The two studies are the first in a library of industry studies contemplated by the Department of Labor.

It is obvious that these findings have value for policy formulation. Indeed, the work on tariff formulas has already been used extensively by several government agencies. The quantitative estimates of employment impact promise to be of special importance when the trade negotiations become more detailed.

Adjustment to Changing Trade Patterns

When employment in a particular industry falls because of increasing imports, it is customary to treat the reduction in employment as equivalent to the number of jobs lost or the number of layoffs required. Yet, the number of layoffs is not necessarily equal to the employment reduction. In the normal course of events, some workers in the industry will quit voluntarily, some retire, die, etc. The number of required layoffs is less as a consequence. One study in this section attempts to establish the relationship between a fall in demand for an industry's output and the number of layoffs required, taking into account normal attrition of the industry's workforce. The subject is also treated in the steel industry paper noted above.

Another paper in this subject area provides estimates of the long-term earnings losses of workers displaced in eleven industries. The estimates range from about 25 percent earnings loss in some industries to zero loss in others. In general earnings losses are higher among the prime-age males studied in industries where wages are high and attrition rates low.

Issues in trade policy frequently turn on the matter of adjustment costs. Escape clause cases, for example, frequently involve consideration of the expected number of layoffs. The selection of industries for trade liberalization should take into account the costs imposed on workers in the industries under consideration, especially since the worker adjustment costs appear to vary greatly among industries. These studies can help in such issues.

It is worth noting that the findings do not relate only to trade matters. If the papers have value, they should apply to labor adjustment costs, whatever the cause of displacement.

Foreign Investment

The one element characteristic of all the papers in this section is the diffidence with which the empirical results are presented. In view of the difficulties in studying the subject, noted previously, the diffidence is probably warranted.

On the matter of whether U.S. multinationals could serve export markets by domestic production rather than foreign production, one paper reports no statistical evidence of association between U.S. exports or imports and U.S. investments abroad. This suggests that U.S. production abroad does not reduce U.S. exports (or increase imports) and, therefore, has little impact on U.S. unemployment. But another paper concludes that prohibitions of foreign investment would increase domestic employment demand substantially. Other findings on the impact of foreign investment include an estimate of duration of unemployment for displaced workers (a matter of months) and a moderate redistribution of income favoring capital.

A third paper treats the transfer of technology on the basis of twenty-five case studies. The paper suggests that if current trends continue, the industrial composition and competitive position of the United States could be altered in important ways and significant adjustment costs imposed.

It is hard to argue that the papers in this section present clear, or even fuzzy, guides to policy making. Perhaps the most that can be said is that the impact of foreign investment continues to be a research area of high priority.

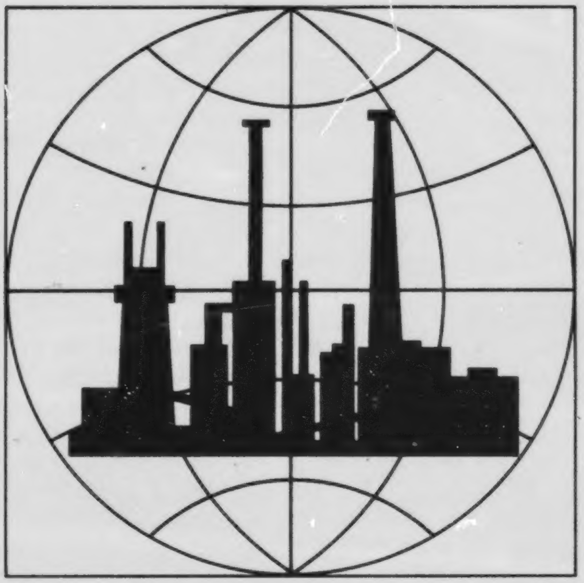
Conclusion

The papers I have been summarizing so cavalierly need not be thought of as definitive; nor should anything else in empirical economics. But they do constitute a good measure of current research directed to complex and important policy matters. And in any event, the alternatives to policy making without serious research are unappealing. The volume is worth reading. Go ahead!

It is customary in an introduction of this sort to thank "the people who made it possible." Yet, I am not inclined to do so. The authors were paid for their work, Department of Labor Officials should not be thanked for starting a program that should have been started years before it was, and the taxpayers who, in fact, made it possible were not even consulted. But if the program has merit, the people most responsible are the directors: Donald Gordon now at Simon Fraser University, William Dewald now at the Ohio State University, and Harry Grubert, the current director. For the selection of these outstanding and highly professional people, I unblushingly take full credit.

Part One

Industry Studies



Introduction

Harry Grubert

The papers in this session are two examples of a series of industry studies by the Bureau of International Labor Affairs. In addition to these two, studies have been completed on oil, footwear and sugar, and are underway on chemicals and electronics. Each of these studies takes a close look at the special features of a particular industry in contrast to some of the more broad ranging projects reported in other sessions.

The steel project reported by Mr. Jondrow for the Public Research Institute was the first major industry study undertaken by the Bureau of International Labor Affairs (ILAB). It was intended as a prototype for the series in the sense that its components would tend to be found in the other industry studies. These industry study elements are (1) an analysis of the responsiveness of import demand to relative prices; (2) the determinant of domestic and foreign prices; (3) the relationship between changes in domestic output and employment; and (4) the estimation of losses in lifetime earnings incurred by displaced workers in the industry. This last area, earnings losses, is one in which ILAB research has pioneered. It is reported on more fully in the paper by Louis Jacobson in the session on labor adjustment.

Although each of the industry studies tends to have similar components, the paper by Eric Toder on automobiles demonstrates that every industry has special features which necessitate differences in the analysis. In automobiles, the differences in characteristics among makes of cars and the differing tastes of consumers for these characteristics create special problems. A time series analysis relating imports to the relative prices of imported and domestic cars is not entirely adequate. It is not enough to adjust price indices for the changing characteristics of cars using so-called hedonic methods which make adjustments for differences in characteristics. For not only will demand for imports depend on relative prices, holding quality constant, but also on how many makes of particular types of cars are available. For example, there may be a switch to domestics if U.S. producers start to make cars that are closer to foreign automobiles in terms of size and performance. Because of the need to enrich the demand analysis, the automobile project developed the hedonic share model described by Mr. Toder.

In part because of the variety of consumer tastes, economies of scale seem to be significant in the automobile industry. The study, therefore, found it necessary to make a close examination of the minimum efficient scale for automobile plants. This information, in turn, becomes important in predicting what kinds of cars will be produced in various locations. For example, Mr. Toder suggests that as the market for German and Japanese small cars expands in the United States, Japanese and German producers may well find it efficient to establish plants in this country, a development that, of course, has already started.

Returning to demand for a moment, I do not wish to imply that the analysis of demand for steel is particularly straightforward. Indeed the apparent uniformity in quality between foreign and domestic steel raises a question of its own. Why do foreign and domestic steel sell at different prices at any time, and further, why does the price differential change substantially, as it does, over time? Mr. Jondrow has examined this problem in a follow-up study that is just being completed and found that foreign and domestic steel are not really identical products from the purchaser's point of view. Foreign steel takes much longer to get delivered after being ordered, and the delivery lag is more variable. Moreover, the buyer who depends on foreign steel will experience greater variability in price. These factors increase inventory and other costs which means that many customers will be willing to pay a substantial premium for domestic steel.

It may be useful for me to point to a few similarities and contrasts in the auto and steel study results. Both find that the price elasticity of the demand for imports is relatively low in the short run, but seems to be very large in the long run. On the other hand, domestic price setting behavior in the auto and steel industries seems to differ. It is estimated that domestic steel prices are unaffected by changes in import prices, but that domestic automobile prices respond to import competition significantly. The automobile study did not investigate the formation of foreign prices, but the steel results are of interest. Mr. Jondrow finds that import prices are highly responsive to capacity utilization abroad, in contrast to domestic steel prices which appear unaffected by demand conditions, a contrast which Professor Houthakker specially notes in his comment.

In conclusion, I would like to emphasize the fact that the objective of these studies is to improve the evaluation of trade policy. When changes in trade barriers are considered, it is critically important to know how domestic demand responds to import costs, how employment will be affected, and what will be the impact of the labor market experience of workers in the industry. The two industry studies presented here are an attempt to expand the amount of available information on these questions.

Effects of Trade Restrictions On Imports of Steel

James M. Jondrow*

Introduction and Summary of Results

In analyzing the relative merits of free and restricted trade, economists have tended to concentrate on the net long-run effects: whether the long-run gains to one group exceed the losses to others. This paper uses an econometric model to estimate the short-term gains and losses to particular groups from free trade in the steel industry. Because there has not been free trade, we studied what would have happened had there been free trade in the period 1969–73.

During 1969–73, there were two trade barriers. One, a tariff of about 7 percent, had existed for a long time, but was declining because of the Kennedy Round agreements. The other, a voluntary quota starting in 1969, had been accepted by Japan and the European Common Market, the major steel exporting countries.

One central finding of the study is that removal of import barriers would not have led to a sudden shrinkage of the domestic industry. Import penetration would have built gradually. In the first year of our period of study, imports would have displaced less than 2 percent of domestic shipments. This percentage displacement would have increased gradually to about 8 percent four years later.

Employment would have been reduced more than proportionately to output because the oldest, most labor-intensive equipment would have been most affected. The employment reduction would have been gradual, and would have come about, in part, by attrition. Still, there would have been some layoffs. We estimate that removal of trade barriers would have induced annual layoffs in the first years, averaging to roughly 3 percent of the labor force. On the average, each displaced worker would have lost in lifetime earnings an estimated $6 thousand (in 1960 dollars).

There would have been losses to the steel industry. In the year of greatest effect, losses to industry would have amounted to about 3 percent of gross revenue and would have approximately eliminated net income in that year.

Removal of import barriers would have generated gains to purchasers of imported steel. These gains, in the form of lower prices, would have accrued both to industries using steel and to consumers of steel-using products. We estimate that these gains would have more than offset the total losses to steel workers and the domestic industry.

The Historical Context

Before 1958, imports were not much of a challenge. Then in the late 1950s, the import price dropped sharply from well above the domestic price to about 15 percent below. The import price remained 10 percent to 20 percent below the domestic price during most of the next ten years, whereas the import share grew from less than 2 percent to almost 17 percent in 1968.

Several reasons have been offered for the weakening of the domestic steel industry's competitive position. The "over-valuation" of the dollar has been suggested by Floyd [8] as a cause for the U.S. trade deficit in general and by Thompson [15, p. 87] as a cause of growth in steel imports.

In addition, American comparative advantage may have been shifting away from steel. The steel industry in the United States, relying on relatively old plants, had lost some of its technical superiority over foreign producers. Evidence for this position offered by Dirlam and Adams [2] is the slower U.S. adoption of the basic oxygen furnace. In addition, foreign steel industries had begun to recover from World War II. Thorn [14] suggests that the U.S. industry also faced much higher wage costs than their foreign competitors.

A source of import penetration not related to comparative advantage is the existence of "excess" capacity in foreign countries [15, pp. 17–27]. Another is the policy of the domestic steel industry to hold prices constant in the face of import competition [1, pp. 627–29]. Indeed, when imports precipitated a temporary price war in 1968, the press commented that price cutting was a tactic domestic firms had long avoided [16].

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*This paper is based on "Removing Restrictions on Imports of Steel," ILAB 73-8 by James Jondrow, Eugene Devine, Louis Jacobson, Arnold Katz, and David O'Neill, Public Research Institute, Center for Naval Analyses, 1975.

Finally, American labor disputes encouraged imports. The first major inflow of imports coincided with the record 116-day steel strike in 1959. To replace lost domestic shipments, purchasers turned to imports, more than doubling import tonnage. After the strike, the import share did not return to its pre-strike level, perhaps because American purchasers had gained familiarity with imports.

Throughout the sixites, the persistent import price advantage led to a steady increase in the import share but, in addition, import penetration always increased when a strike was threatened.

By 1968, the import share had reached a peak of almost 17 percent. Though part of this was due to hedging before a possible strike, it still generated concern in Congress. To head off a possible mandatory quota, the major exporting countries agreed to the voluntary quota.

The quota covered the five years 1969–73. Since import penetration was still increasing when the quota was instituted, a stable equilibrium had not been reached. The effect of the quota was to limit further import penetration.

The quota was not the only factor limiting imports in this period. Higher world demand (especially in 1969 and 1973), increasing foreign labor costs, and dollar devaluations all would have played a part if the quota had not been in effect. In the final year of the quota, 1973, these factors created such a high import price that the quota was not binding.

There have been violent cyclical swings. During late 1973 and 1974, there was an extreme worldwide shortage in steel, resulting in import prices far above the domestic price. Then, in 1975, world demand fell sharply and the import price fell below the domestic. The fall in U.S. demand was accentuated by consumer inventory rundown and the resulting drop in domestic mill shipments was unprecedented in the postwar period. As world markets recovered in early 1976, the import price approached the domestic price, but since then, the import price has again fallen below the domestic.

One of the most striking facts about the steel industry's long period of vulnerability is that import penetration was so slow. Although the penetration was unrelenting, imports never threatened to take over the market.

An Overview of Methods Used to Estimate The Effect of Free Trade

Our estimate of the effect of removing the tariff and quota begins with an analysis of competition between imported and domestic steel. Statistical relations are estimated which represent the behavior of participants in the steel market, domestic steel purchasers, domestic suppliers, and foreign suppliers. These relations are used to estimate the hypothetical effect of removing restrictions on steel imports in 1969 and leaving them off through 1973. The effects are summarized as differences due to free trade in domestic shipments, prices, import shipments, and import prices.

The estimated effect on domestic shipments is then used to estimate employment and earnings, and to estimate the effect on the welfare of particular groups.

The next section describes some of the data used for estimation. This is followed by a more detailed description of the methodology and results.

The Data Used for the Study

Much of the data used in this study was taken from standard sources. For example, tonnage figures for imports and domestic shipments were available from the American Iron and Steel Institute *Annual Statistical Report*. These series are reprinted in the Commerce Department's *Survey of Current Business*. Some important data were not available from government statistical series; as a result, we found it useful to go to basic sources.

For example, there is no U.S. government price index for imported steel. Perhaps the closest measure is the unit value of imported steel, the customs value divided by import tonnage. This is not very accurate, however, since a shift from lower to higher valued steel will increase the unit value, even if the actual price is unchanged. In addition, the valuation for a given item can be determined in a number of ways and "frequently does not reflect the actual transaction value" [11, p. 1].

To construct an import price index, we used trade press quotations of export prices for Japan and the Common Market. These prices are published for particular types of steel in the British trade journal, *The Metal Bulletin*. The individual prices were weighted and aggregated into a single index of the foreign dollar export price.

To this export price, we added transport and tariff costs to approximate the U.S. landed price. The transport cost index was constructed from data in *Chartering Annual* [5]. The percentage tariff was constructed as a fixed weighted average of numerous individual tariffs.

We also needed basic data to form an index of foreign materials cost. Such an index was readily available for Japan, since the Japanese government publishes a set of input-output price indices for various industries, but for

Europe, it was necessary to create an index of steel input costs from price indices for separate factors. (German factor prices were used to represent European costs.)

A More Detailed Description of Methods Used to Estimate the Effect of Free Trade on Prices and Output

The economic model of the steel market used to estimate the impact of free trade has four behavioral equations. The first two describe demand: the substitution between imported and domestic steel and the substitution between steel and other products. The remaining two behavioral equations describe supply: price setting behavior by producers of domestic and imported steel. The model is completed with several identities.

The following sections give a general description of the equations and results. The equations themselves are presented in Appendix A.

Substitution between imported and domestic steel. The first equation describes the choice between domestic and imported steel. The variable to be explained is the ratio of imports to domestic shipments.

An important determinant is the import-domestic price ratio, an index of landed import price divided by an index of the domestic steel price (represented by the BLS price index for steel mill products). It is estimated that, if trade restrictions increase the relative import price by 1 percent, the dependent variable will fall by 1 percent during the first year. This effect is statistically significant; its level is almost eight times its standard error.

The relative price variable measures only the short-run effect of prices. To represent the lagged effect of prices and other variables, we include several lagged values of the dependent variable, which allows the effect of a persisting price change to cumulate.

Table 1 illustrates the cumulative effect of a 1 percent drop in import price.

Table 1

Cumulative Effect of a 1 Percent Fall in the Price of Imported Steel on the Ratio of Imports to Domestic Shipments

	Percent Change in the Ratio
First year	1.0
Second year	1.5
Third year	1.9
Fourth year	2.3
Long-run effect	5.9

Another important determinant of the import-domestic quantity ratio is the expectation of a strike. When a strike is expected, consumers often turn to imported steel because of limitations on domestic capacity and because deliveries during a strike can be guaranteed only by import suppliers. The estimated equation indicated that a period of hedging against a strike, such as the one in 1968, would increase the dependent variable by about 3 percent.

Substitution between steel and other products. In addition to encouraging substitution into imports from domestic steel, free trade also encourages substitution into steel from other products. The second equation describes the degree of substitution into steel, estimating how consumption of steel changes when the price of steel falls.

The dependent variable in this equation is a measure of the total amount of steel, domestic and imported. The measure is not the sum of the two types of steel, but a slightly more complex magnitude based on the assumption that the two are imperfect substitutes with a constant elasticity of substitution.

This dependent variable turns out to have only a limited sensitivity to the price of steel as a whole. A 1 percent drop in the price of steel, relative to the price of steel-using output, leads to a 0.4 percent rise in steel shipments. Even if free trade lowers the price of steel, steel consumption will not increase much.

Other determinants of steel demand are output in steel-using industries and lagged steel shipments. Output has a powerful effect, indicating that steel is a highly cyclical industry. Lagged steel shipments have a negative effect. This probably indicates inventory adjustments. A high value of last year's shipments, holding constant this year's desired consumption, means that inventories will need to be reduced this year, reducing this year's shipments.

Inventory adjustment seems to have been partially responsible for the precipitous drop in steel shipments in early 1975. Inventories built by purchasers trying to protect themselves against the shortage in late 1973 and 1974 and the expected 1974 coal strike were liquidated in early 1975 as demand dropped.

The remaining determinant of steel demand is a simple time trend with a negative effect of about 1.8 percent a year. The trend may represent the discovery of new applications for competing materials such as plastics, cement, and aluminum.

The supply price of domestic steel. The variable to be explained is the BLS Wholesale Price Index for steel mill products. Imports could affect the domestic price by creating slack in the demand for domestic steel. However, we did not find that capacity utilization was an important determinant of price, which suggests that

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domestic price will not fall sharply to limit import penetration. This result does not seem to stem from inaccuracies in the price measure. The one major study directed toward measuring the extent of discounting found it unimportant for steel [13, pp. 72–74]. Variables that did seem to affect price were input costs and the price in the previous year.

The supply price of foreign exports. This equation explains an index of the foreign export price. The major issue is whether this export price is affected by U.S. import demand. If so, then trade restrictions will tend to lower the foreign export price.

U.S. demand can affect the export price either as part of world demand or through some independent mechanism. The empirical analysis suggests that our demand is important only as part of world demand, not independently. Entering our demand as a determinant of foreign export price did not yield successful results. Since our import demand is only a small part of world demand, the export price does not depend importantly on U.S. import demand. Hence, foreigners are unlikely to bear a large fraction of any burden imposed by trade restrictions.

Though our import demand does not influence the foreign export price, world demand does. We estimated that a 10 percent increase in world capacity utilization raised foreign export prices by almost 20 percent. Foreign materials prices and technical change also influenced the foreign export price.

The effect of the quota was measured within the import price equation. The presence of the quota was measured by dummy variables for the quota years 1969 to 1972. A quota variable was not included for 1973, since the quota was nonbinding in that year.

The coefficients on the quota variables are estimates of the tariff equivalent of the quota, i.e., the tariff that would restrict imports the same amount. This tariff equivalent ranges from 19 to 28 percent depending on the year; the same order of magnitude as those reported by Floyd [7, p. 133]. His estimate is based on comparisons of prices of Japanese steel in Canada and the United States.

In interpreting the estimated tariff equivalent, we note that the dependent variable is a posted world export price, not necessarily specific to U.S. purchasers. Foreign producers with rights to sell under the U.S. quota receive a monopoly rent, creating a difference between the world export price and the price to the United States. The question is, Which price is measured by posted prices during the quota period?

We answered this question empirically. We entered the quota variables in both the export price relation (as discussed in this section) and in the import-domestic substitution relation. If the quota rent is included in posted prices, the quota variables should be significant in the export price equation. If the quota rent is not included, the quota variables should be significant instead in the import demand equation. That is, actual import prices to the United States will be underestimated by posted prices during the quota period and the quota variables will pick up this underestimation. Thus, they will be significant determinants of the ratio of imports to domestic tonnage in the import demand curve.

The results indicated that the rent attributable to the U.S. quota was included in the posted price during the

Table 2

The Estimated Effect of Import Restrictions 1969–73

Year	(1) Actual	(2) Predicted with Trade Restrictions	(3) Predicted without Trade Restrictions	(4) Effect of Trade Restrictions as a Percent of Column (2)
	Imports of Steel Mill Products (in thousands of net tons)			
1969	14,034	13,600	16,900	−25
1970	13,364	12,000	16,100	−34
1971	18,304	16,800	26,000	−54
1972	17,681	17,300	27,500	−58
1973	15,152	14,600	21,800	−48
	Domestic Shipments of Steel Mill Products (in thousands of net tons)			
1969	93,877	98,600	97,100	1.5
1970	90,798	90,770	87,900	3.1
1971	87,038	87,800	81,800	6.8
1972	91,805	95,400	87,700	8.1
1973	111,430	111,000	103,163	6.8
	Import Price (index base 1967)			
1969	1.27	1.33	1.04	21
1970	1.36	1.38	1.10	20
1971	1.15	1.15	0.86	26
1972	1.29	1.27	1.03	19
1973	2.09	1.98	1.87	5
	Import Share			
1969	0.14	0.13	0.16	−23
1970	0.14	0.13	0.17	−33
1971	0.18	0.17	0.25	−50
1972	0.17	0.16	0.25	−55
1973	0.12	0.12	0.18	−49
	Capacity Utilization			
1969	0.93	0.97	0.96	1.5
1970	0.86	0.86	0.83	3.1
1971	0.78	0.79	0.74	6.8
1972	0.87	0.90	0.83	8.1
1973	0.98	0.97	0.90	6.8

quota period and other purchasers received discounts from this. This result is consistent with the fact that quoted prices usually refer to the maximum price where different purchasers pay different prices. Note that it is also consistent with the foreign exporters receiving the quota rent.

Identities. The behavioral relations discussed above are supplemented with several identities. One shows the exchange rate conversion between the export price in foreign currency and the export price in dollars. Another adds transport costs and the tariff to the foreign dollar export price to form the landed import price, the price used to estimate substitution between imported and domestic steel.

The Impact of Free Trade

The model outlined above was used to estimate how free trade would affect the U.S. steel market between 1969 and 1973. As shown in Table 2, we estimate that imports would have been much higher had trade barriers not existed. Import tonnage would have grown to an estimated peak of 27.5 million tons in 1972 compared with the 17.3 million tons actually imported.

The effect of trade restrictions was to limit the import share to about the prequota level (see Figure 1). The restrictive effects of the tariff and quota increased over time; they are estimated to have reduced imports by 25 percent in the first year and by almost 60 percent in 1972, the year of the peak effect.

Trade restrictions had a major impact on import price, as much as 25 percent in some years; yet imports are a small fraction of U.S. consumption, so a substantial restriction of imports still does not translate into a large percentage increase in domestic shipments. In fact, we estimate that the largest increase in domestic shipments due to the tariff and quota was 8 percent. Had there been no trade restrictions, the main effect of import penetration would have been to accentuate the cyclical downturn in domestic steel shipments in 1970–72: 1970 would have remained a mediocre year; 1971 would have become a very weak year; and 1972 would have been a mediocre rather than a good year.

The effect on employment. Still to be determined is how the output changes described above would affect employment, and the welfare of specific groups. To convert output changes to employment changes, we used the work of Arnold Katz of the University of Pittsburgh. Katz's research describes the way in which

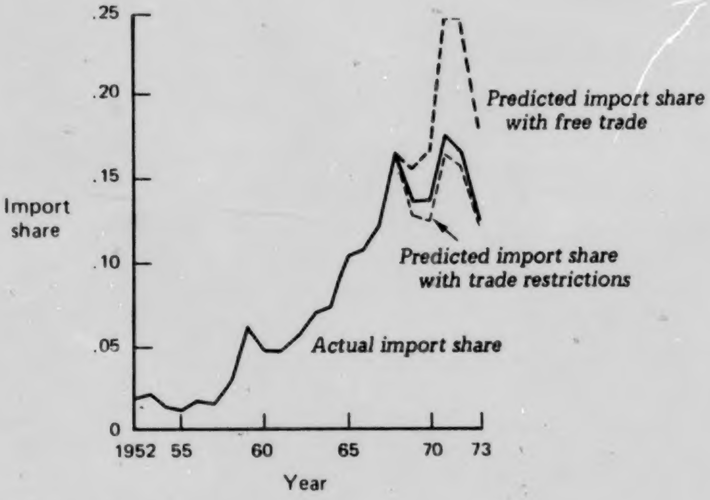

Figure 1

The Share of Imports in Apparent Consumption — Actual, Predicted with Free Trade, and Predicted with Trade Restrictions

labor requirements depend on the age of the capital stock [11]. Older plants tend to be more labor intensive than the industry's average plant, and hence have higher variable costs. These are the plants most likely affected by the trade, hence employment losses are more than proportional to output changes. Indeed, Katz has estimated that the older, marginal plants are about twice as labor intensive as the industry average, so that a permanent 1 percent drop in output leads to a 2 percent drop in permanent employment.

The permanent employment effect of output changes is delayed by labor hoarding, which explains why employment varies less than output over the cycle. A business will generally not know whether an observed drop in demand is permanent. If it is judged to be temporary, laying off workers may be costly; some will find other work. Increasing output back to "normal" requires hiring new workers with attendant search costs and training costs. Because of these costs, management tends to delay some layoffs until it becomes sure that the fall in demand is permanent. Katz estimates that, in the steel industry, only 50 percent of any long-term employment drop is made in the first year of declining demand. The remaining half is delayed until the second year.

We applied Katz's model to translate output changes to employment changes. First, actual employment was assumed to be desired employment in the presence of trade restrictions. (Note, this implicitly ignores labor hoarding in the actual employment figures). Experiments with relaxing this assumption tended to lower the costs of free trade (leaving the gains unchanged). To derive desired free trade employment, we adjusted actual employment by the estimated percentage effect of free trade on employment, twice the percentage output effect.

Table 3

Employment Estimates With and Without Free Trade

Year	(1) Predicted Employment with Trade Restrictions	(2) Predicted Employment with Free Trade	(3) Effect of Trade Restrictions as a Percent of Column (1)
	Employment in SIC 331 (Adjusted for manhours) thousands of workers		
1969	659.8	643.6	2.5
1970	628.4	589.4	6.2
1971	578.1	544.5	5.8
1972	584.4	494.6	15.4
1973	628.4	518.8	17.4

The desired employment under free trade was then adjusted to allow labor hoarding. Using Katz's result, we assumed that in the first year the firm retains one-half of the workers it intends finally to lay off. If, in the next year, demand does not return to "normal," workers hoarded from the previous year are laid off, and one-half of the new employment adjustment is made. We used the employment figures, after labor hoarding, to estimate layoffs with and without free trade. In doing this, we subtracted an assumed 1.5 percent natural attrition.

As can be seen from Table 3, the effect on employment cumulates because of gradual adjustment in domestic output and because of labor hoarding. The effect on layoffs (Table 4) was much smaller. Only in two of the five years in which the quota existed would free trade have increased estimated layoffs. In 1970 an additional 3.5 percent of the industry's labor force would have been laid off. In 1971 the estimated difference is 8.4 percent of the labor force.

The effect on welfare of specific groups. Gains and losses to specific groups include:

- gain to steel purchasers
- loss to steel manufacturers
- loss to steel workers
- loss of tariff revenue.

The gain to consumers is estimated using a standard technique, consumer's surplus (see Appendix B).

Table 4

Layoff Estimates With and Without Free Trade

Year	Predicted Layoffs with Trade Restrictions	Predicted Layoffs with Free Trade	Effect of Free Trade as a Percent of Employment
	(Layoffs in thousands of workers)		
1969	0	0	0
1970	21.5	44.6	3.5
1971	40.9	36.1	−0.01*
1972	0	41.6	8.4
1973	0	0	0

*Though estimated layoffs are generally higher under free trade, there is one exception. Free trade layoffs in 1971 are slightly below layoffs with trade restrictions. This results from the fact that labor hoarding is taken into account in the free trade case, but not in the actual employment figures used to represent the situation with trade restrictions. Labor hoarding under free trade spreads the desired employment drop over two years, making the 1971 free trade layoffs smaller than with no trade restrictions. The delayed layoffs under free trade show up in 1972.

The loss to steel manufacturers is of two types. First there is the cost of labor hoarded. We assume that this labor is not used, so that the loss to industry is the salary of the hoarded labor, which undoubtedly overstates the cost to industry since the extra labor probably has some productivity.

There is also a further loss of profits. This is the area above a competitive supply curve, or marginal cost curve, usually termed producer's surplus. We did not observe an upward sloping supply curve for steel in our empirical work; instead we found that the price is unresponsive to market conditions. However, Katz's work on costs for equipment of different ages suggests a shape for the marginal cost curve, which can be used to estimate profit losses.

Losses to labor were estimated by comparing the long-term earnings of displaced steel workers with the earnings of similar workers who remain. Jacobson [9] estimates that the lifetime earnings losses per steel worker laid off are $6,300 in 1960 dollars. To get total costs, we adjusted this figure to 1969 dollars using the wholesale price index (as used throughout the paper) and multiplied it by the number of layoffs induced by free trade. Losses of tariff revenue are estimated as import values (at the foreign port) multiplied by the percentage tariff. The estimated gains and losses to specific groups are shown in Table 5.

The discounted sums shown in Table 5 are present values in 1969 dollars. Gains and losses for individual years are first deflated to 1969 dollars using the wholesale price index, then discounted back to 1969, using a real interest rate of 5 percent.

As can be seen from the table, gains to steel consumers are sizeable, about $2.8 billion. Much of this is a transfer from other groups. The largest losses are not to labor, but to shareholders in the steel industry. They lose about $1.1 billion in profits, which includes about $0.85 billion due to labor hoarding. Losses to taxpayers in tariff revenue are another $0.7 billion, and losses to labor are a somewhat more modest $0.4 billion.

Adding the gains and losses yields a net gain of about $0.62 billion. If redistribution is thought to have some cost, this net gain is not costless. The net gain necessitates a transfer of about $2.2 billion, or over three times the net effect. Part of this transfer is from taxpayers, not a concentrated group. The transfer from labor and industry is about $1.5 billion, more than twice the net effect.

Though the adjustment for free trade requires losses that are large in relation to the net gains, the losses are not sudden, nor are they large in relation to industry revenue or payroll.

In the worst year for layoffs, the expected lifetime earnings loss was less than 5 percent of payroll. The

Table 5
Gains and Losses Due to Free Trade

Year	Gains to Steel Purchasers (millions)
1969	$539
1970	610
1971	1048
1972	903
1973	267
Discounted sum	2839
	Losses to Workers (millions)
1969	$ 0
1970	170
1971	−36
1972	329
1973	0
Discounted Sum	379
	Losses to Industry from Labor Hoarding (millions)
1969	$ 43
1970	300
1971	578
1972	73
1973	0
Discounted Sum	864
	Losses to Industry Producer's Surplus (millions)
1969	$ 1
1970	38
1971	141
1972	95
1973	30
Discounted Sum	249
	Losses of Tariff Revenue (millions)
1969	$141
1970	151
1971	195
1972	205
1973	189
Discounted Sum	726
	Total Gains Minus Total Losses (millions)
	$621

largest single year loss to industry was modest in relation to revenue, about 3 percent; however, it would have exhausted net income that year.

Some of the losses described above do not usually appear in calculations of the net gains from trade. The loss to industry in the form of payments for hoarded labor is usually not included, on the assumption that the industry moves immediately to its new equilibrium level of employment. One argument for this is that labor hoarding is a purely cyclical phenomenon. On the other hand, it seems unlikely that the effects of permanent output changes can be distinguished easily from cyclical changes. Hence, the uncertainty and reaction to it might be similar.

Also omitted from the usual gains and losses calculation is the loss of industry profits and labor earnings. The rationale is that a competitive supply curve represents the opportunity costs for both labor and capital. Hence, any losses they would suffer are completely included in the steel price drop they are willing to accept. But, it turns out, this loss is exactly offset by a gain to consumers of the domestic product. The gains to consumers of the domestic product and the losses to capital and labor cancel, leaving a net gain only to consumers of the imported product.

We do not assume this cancellation for the steel industry because neither the steel price nor wage seems sensitive to short-run demand conditions. Yet, the existence of marginal plants alongside much more modern ones suggests that the industry has an upward sloping marginal cost curve, as discussed earlier.

We limited our study to specific years and to gains and losses to specific groups. A word should be said, however, about the welfare effects that lie outside this focus. First, if import penetration causes an adjustment in the exchange rate, or a downward adjustment in the general domestic price level, our exports will become more competitive. If the United States has monopoly power in export markets, import trade restrictions will help us exploit this and shift the terms of trade in our favor. Removing import restrictions prevents us from exercising our monopoly power as effectively. We have not taken account of this.

On the other hand, the gains to import consumers will extend indefinitely into the future. The adjustment costs to industry and labor, all the costs but the lost tariff revenue, will die out as adjustment becomes complete. Hence, limiting the study to the first few years of free trade could lead to massive underestimates of the net gains.

Appendix A

Equations Used to Describe the Steel Market

The results in the text are based on an econometric model. The model has four behavioral equations (discussed below) and a number of identities.

Background on the demand curves. There are two demand equations, one representing the substitution between imported and domestic steel, the other representing the demand for steel as a whole. These equations are derived from a CES production function for steel-using commodities y. The production function is assumed to be of the following nested type, as described in [4].

$$y = A\{b_1 s^{-\alpha} + b_2 x^{-\alpha}\}^{-1/\alpha},$$

$$s = \{c_1 q^{-\beta} + c_2 m^{-\beta}\}^{-1/\beta}.$$

The first production function is homogeneous and depends on an index of steel input s, constructed as a CES function of m (import tonnage) and q (domestic shipments to domestic purchasers). The coefficient α measures substitutability between steel and other inputs, the elasticity of substitution being $\delta = (1 + \alpha)^{-1}$. Similarly, the coefficient β represents substitutability between imported and domestic steel.

Profit maximization by firms, taking as given the price of output, results in the following factor demand equations:

$$\frac{m}{q} = \left(\frac{c_2\ p_q}{c_1\ p_m}\right)^{\sigma} \text{ or}$$
$$\ln\left(\frac{m}{q}\right) = \sigma \ln\left(\frac{c_2}{c_1}\right) + \sigma \ln\left(\frac{p_q}{p_m}\right), \tag{1}$$

$$s = k\left(\frac{p_y}{p_s}\right)^{\delta} y \text{ or}$$
$$\ln(s) = \ln k + \delta \ln\left(\frac{p_y}{p_s}\right) + \ln(y), \tag{2}$$

where

p_m = price of imported steel
p_q = price of domestic steel
p_y = price of output

k = constant
σ = $(1+\beta)^{-1}$
δ = $(1+\alpha)^{-1}$
p_s = composite price for steel, which can be defined by the relation $d \ln p_s = v_m d \ln p_m + (1-v_m)\, d \ln p_q$, where v_m is the import value share
y = output of steel-using commodities.

For estimation, both (1) and (2) are assumed to hold in long-run equilibrium. Actual estimation employs lagged values of left-and-right-hand variables to allow for gradual adjustment. These short-run forms approach (1) and (2) as adjustment becomes complete.

Before proceeding to estimates of individual equations, it is necessary to discuss a general econometric issue. The model includes almost as many predetermined variables as observations. Hence, two-stage least-squares is virtually the same as ordinary least-squares. Obvious alternatives are to use a subset of the predetermined variables or a set of principal components. However, the first seems arbitrary and involves throwing away information. The latter is subject to the scale problem. Moreover, the endogenous right-hand variables turn out to be not very endogenous. Hence, the low variance of least-squares may well outweigh its asymptotic bias. For these reasons, ordinary least-squares is used for estimation. To correct for first-order serial correlation, generalized least-squares is employed.

The substitution equation. The substitution equation (equation (3)) is estimated using a Jorgenson rational lag (hence the lagged values of m/q) and an added variable H to measure hedging before a possible strike. Before each major negotiation, steel users build inventories, domestic shipments become large, domestic capacity often proves inadequate, and users often turn to imports. After the agreement is reached, domestic shipments fall off suddenly. A measure of the hedge's intensity is the ratio of maximum monthly shipments during the year to average monthly shipments. Our variable H is this ratio multiplied by the estimated length of the hedge. The length measure is provided in the 1968 *Steel Import* study [15, pp. 149–56] with our own extensions for more recent years.

Equation (3): Substitution Equation — Annual Data 1956–73 (*t* values in parentheses)

$$\ln\left(\frac{m}{q}\right) = \underset{(-3.00)}{-0.394} - \underset{(-7.93)}{0.994} \ln\left(0.84\frac{p_m}{p_q}\right) + \underset{(6.74)}{0.454} \ln\left(\frac{m}{q}\right)_{-1} + \underset{(3.21)}{0.265} \ln\left(\frac{m}{q}\right)_{-2} + \underset{(1.56)}{0.113} \ln\left(\frac{m}{q}\right)_{-3} + \underset{(7.61)}{0.037}\, H .$$

R^2 (on transformed data) = 0.98
$N = 18$
d.f. = 12
D-W = 1.79
$\rho = 0.542$,

where

m = tonnage imports of steel mill products
q = domestic tonnage shipments of steel mill products to domestic users
p_m = index (base 1967) of the dollar price of imports including tariff and transport. It is constructed from export quotations for the common market and Japan. These export quotations were used to form a fixed weight measure of the dollar export price. To this we added a measure of tariff and transport costs. The former was based on a fixed weight average of U.S. steel tariffs. The latter was based on an index of tramp steamer rates published in [5]. The dollar import price, thus formed, was then expressed as an index, base 1967. In estimation, the index is multiplied by 0.84, since in 1967 the median import price was about 16 percent below the domestic [15, pp. 409–10]
p_q = domestic price as measured by the BLS wholesale price index for steel mill products
H = measure of temporary hedge demand.

This regression suggests that imported and domestic steel are fairly substitutable, even in the short run. The elasticity of substitution after one year is about unity. The long-run elasticity of substitution is much higher, about 6, since only 17 percent of the adjustment takes place in the first year.

The demand for steel as a whole. The demand for steel as a whole expresses the steel input index s as a function of the steel price index p_s, the price of output p_y, and output in steel-using commodities y. The variables s and p_s are derived using the assumed CES production function for steel-using commodities.

The composite price index is formed from the relation

$$d \ln p_s = v_m d \ln p_m + (1-v_m) d \ln p_q ,$$

where v_m is the import value share. The resulting measure of p_s is expressed as an index, base 1967. The variable s is formed by the relation

$$s = \left\{c_1 q^{-\beta} + c_2 m^{-\beta}\right\}^{-1/\beta}.$$

Estimates of c_1, c_2, and β are taken from the steady-state form of equation (1).

The aggregation formulas for p_s and s are both based on long-run equilibrium conditions. Hence, they are justified only asymptotically, as the system approaches long-run equilibrium.

The estimates are based on a longer series than used earlier to provide needed variation in the price ratio. Because of the maintained hypothesis of constant returns to scale, the coefficients on output in steel-using industries and the coefficient on lagged steel shipments were constrained to sum to unity.

Equation 4: The Demand for Steel as a Whole—Annual Data 1948–73 (*t* values in parentheses)

$$\begin{aligned}\ln(s) = \underset{(14.44)}{14.44} - \underset{(-3.63)}{0.446} \ln\left(\frac{p_s}{p_y}\right) + \underset{(14.50)}{1.294} \ln(y)\\ -0.294 \ln(s_{-1}) - \underset{(-6.00)}{0.018}t.\end{aligned}$$

R^2 (on transformed data) = 0.955
$N = 26$
d.f. = 22
D-W = 1.92
$\rho = 0.045$,

where

s = composite steel index
p_s = composite price of steel
p_y = price of steel using output, measured here by the overall BLS wholesale price index
y = index of output in steel-using commodities. This is constructed as a weighted average of *Federal Reserve Board* indices of production in the auto, business equipment, and intermediate construction materials industries. Weights are based on relative steel shipments to these sources
t = time trend.

The supply price of domestic steel. The estimated domestic supply curve is presented below as equation (5). A capacity utilization term was tried, but had little effect on the predictive power of the equation. To represent a maintained hypothesis of complete pass-through of cost in the long run, the coefficients on the lagged price and on the cost variable were constrained to sum to unity. Unconstrained results were similar.

Equation 5: The Supply Price of Domestic Steel — OLS — Annual Data 1948–73 (*t* values in parentheses)

$$\ln(p_q) = 0.0053 + \underset{(0.738)}{0.374} \ln(w) + \underset{(13.0)}{0.626} \ln(p_q)_{-1}.$$

R^2 (on transformed data) = 0.99
$N = 26$
d.f. = 24
D-W = 1.61
$\rho = 0.440$.

The supply price of imports. The supply price of imports, like the domestic supply price, was originally expressed as a function of market conditions and costs. In addition, a measure of technical change, the percentage of foreign production using the advanced basic oxygen process, turned out to be important. To represent the effect of the quota, separate dummy variables were entered for the years 1969–72. A 1973 dummy was insignificant, indicating that the import quota was not binding in the tight 1973 market.

The cost measure employed was a weighted average of prices for individual steel-making materials in Germany and Japan. A steel wage index did not add significantly to the explanatory power of the equation, suggesting that foreign steel is priced according to marginal cost and that there is a disinclination to vary employment.

Market conditions were represented in two alternative ways, by the level of imports to the United States, and by world capacity utilization. The former was dropped because of low explanatory power. This means that the United States does not seem to possess important monopsony power in the market for imported steel.

The regression results are presented in equation (6).

Equation 6: The Supply Price of Exported Foreign Steel — Annual Data 1956–73 (*t* values in parentheses)

$$\begin{array}{llll}
\ln(p_f) = & 0.135 & + 1.84\ln(uw) & + 1.10\ln(wf) \\
 & (0.409) & (3.63) & (2.19) \\
 & - 1.09\, bf & + 0.089\, t & + 0.213\, d_{69} \\
 & (1.48) & (1.22) & (3.05) \\
 & + 0.205\, d_{70} & + 0.276\, d_{71} & + 0.194\, d_{72}. \\
 & (2.67) & (2.46) & (1.52)
\end{array}$$

R^2 (on transformed data) = 0.908
$N = 18$
d.f. = 9
D-W = 1.66
$\rho = 0.804$,

where

p_f = index of the foreign export price in foreign currency units deflated by the foreign wholesale price index
uw = world capacity utilization
wf = index of deflated Japanese and German materials prices
bf = fraction of European and Japanese steel made using the basic oxygen process
t = time trend
$d_{69}-d_{72}$ = dummy variables indicating separate years in the period 1969 to 1972.

The positive coefficients on the dummies indicate that the quota had a sharp effect on supply price in these years. Its tariff equivalent seems to be about 20 percent. This helps explain the recent propensity to use quotas, since a tariff of this size would certainly be difficult to obtain.

Appendix B

Techniques Used to Estimate Gains and Losses to Particular Groups

This appendix discusses the conversion of output, price and employment changes into measures of gains and losses. The traditional method of calculating the net gain or loss makes use of consumer surplus, which has always been the source of controversy among economists. The original definition of consumer surplus was the area under the demand curve. This particular measure is often replaced by one based on an income compensated demand curve. The original uncompensated measure is used in this study for several reasons.

First, the income compensated measure requires information not available from our model, namely the demand for each final product using steel. Second, part of the gain from a fall in steel prices is to producers of steel-using goods. It is not clear what type of compensation, if any, is appropriate for these rents. Third, the compensated and uncompensated measures are likely to be close to one another when the level of expenditure on the good is small or when price changes are small. Imported steel, where a significant price change is predicted, is less than one-fifth of 1 percent of GNP.

The Traditional Analysis of Gains and Losses Due to Free Trade

The traditional analysis of consumer gains and losses is from Corden [6]. The analysis assumes that imported and domestic goods are perfect substitutes (an assumption that seems roughly consistent with our results for the long run but not for the short run).

The Corden method treats the demand for imports as the excess demand for the commodity. The supply curve for the domestic product is used to measure the marginal cost of domestic production. For a good description, see [12].

The Modified Version of the Corden Analysis

For use in describing the steel market, we modified the Corden analysis to take into account the following features of the steel market:

- Imported and domestic steel seem to be imperfect substitutes, especially in the short run.
- The price of domestic steel does not seem to fall when demand is slack. This takes place despite an upward-sloping marginal cost curve based on different vintages of capital. Hence, the supply and marginal cost curves seem to differ.
- Because of uncertainty about the permanence of any demand change, steel producing firms do not adjust their work force completely to a drop in demand. There is a cost to them of hoarding the labor when adjusting to free trade.

The modified analysis treats imports and domestic production as imperfect substitutes. Hence, two diagrams are needed, one for imports and one for domestic production.

Figure B-1 represents the import market. When a tariff of T and a tonnage quota of m_1 is in effect, tariff revenues are equal to area X and the quota rent received by foreign producers is XI. When import restrictions are

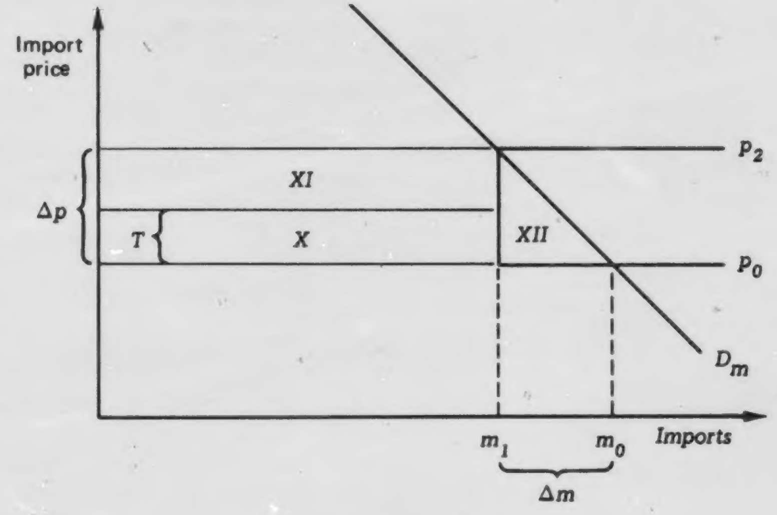

Figure B–1
The Gains to Trade in the Import Market

removed, imports rise from m_1 to m_0, and import price falls from p_2 to p_0. The gain to import users is area $X + XI + XII$. Of this, there is a loss of area X in tariff revenue.

The domestic steel market is described in Figure B-2. The demand for domestic steel is represented by D_1 when trade restrictions are in effect. Domestic price is p_3, which we assume is just equal to full capacity long-run marginal cost *LRMC*. (This assumption is equivalent to defining capacity as including all vintages of equipment that would be profitable to use at this price.) For expositional convenience, we also assume that, in the presence of trade restrictions, domestic production is at full capacity. This assumption is relaxed in actual calculations.

Short-run marginal cost is represented as *SRMC*. The difference between this and long-run marginal cost is the cost of temporarily hoarding labor while assessing the permanence of a drop in demand.

We now turn to the welfare effects of free trade on the domestic steel market. When trade restrictions are removed and the import price falls, the demand for domestic steel shifts inward. Because of the lack of historical responsiveness of the domestic price to market conditions, we assume that import penetration does not lower the domestic steel price. Domestic output falls from q_2 to q_0.

Since the domestic steel price does not fall, consumers of domestic steel do not receive a gain. On the other hand, there is some loss to producers. The loss of long-run profits is shown by the area above the long-run marginal cost curve, areas *XIII* and *XIV*. In addition, there is a further short-run loss in profits due to the cost of hoarded labor. This is represented by area $XV + XVI$.

There is also another cost, not shown. This is the loss of earnings to displaced workers. It should be emphasized that these adjustment costs, losses of profits and earnings, are a net loss only because the domestic price does not fall. If the price always equaled the marginal opportunity cost of labor and capital (as it would under competitive assumptions), then the domestic price would fall when demand was slack. Any losses to capital and labor would be offset by a corresponding gain to consumers of domestic steel.

Algebraic Formulae for Estimating Gains and Losses

The areas that represent gains and losses from free trade need to be expressed in algebraic form to allow

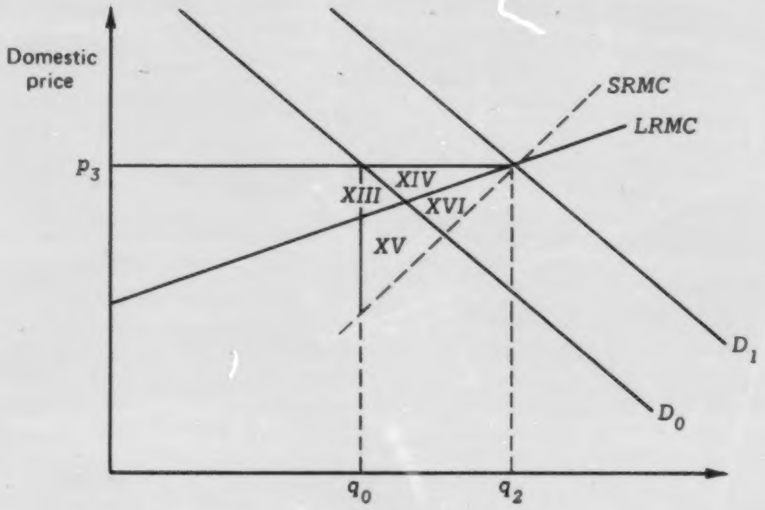

Figure B–2
The Effect of Free Trade on the Domestic Market

numerical estimates of gains and losses to particular groups.

Gains to consumers, shown as areas $X + XI + XII$ in Figure B-1, are approximately equal to the following:

$$\text{consumer gain} = \Delta p \left[m_1 + \frac{\Delta m}{2} \right]$$

$$= \% \Delta p \left[1 + \frac{\% \Delta m}{2} \right] RM,$$

where

Δp = absolute value of the change in the landed import price due to free trade
Δm = change in the import quantity
$\% \Delta p$ = change in the landed price of imports as a percentage of the price with trade restrictions
$\% m$ = increase in import quantity as a percentage of the import quantity with trade restrictions
RM = import revenue including tariff and transport. This is estimated from published import revenue in the foreign port adjusted by our estimates of tariff and transport.

The loss of tariff revenue that would accompany free trade is estimated as the product of the value of imports in the foreign port multiplied by the percentage equivalent of the tariff.

The loss of industry profits is based on the long-run marginal cost. This is shown as areas $XIII + XIV$ in Figure B-2. This area is approximately equal to

$$\text{profit loss} = \frac{\Delta LRMC[\Delta q]}{2},$$

where $\Delta LRMC$ is the drop in marginal cost from lower output due to free trade and Δq is the drop in domestic shipments.

In practice, a modified version of this formula was used to reflect the fact that the industry would not have been operating at full capacity, even when trade restrictions are in effect. Hence, part of the profit loss, measured from full capacity, would occur in any case. The new area representing profit loss is shown as the shaded area in Figure B-3.

In Figure B-3, q_c is full capacity shipments, q_2 is shipments with trade restrictions, and q_0 shipments with free trade. The shaded area can be evaluated as

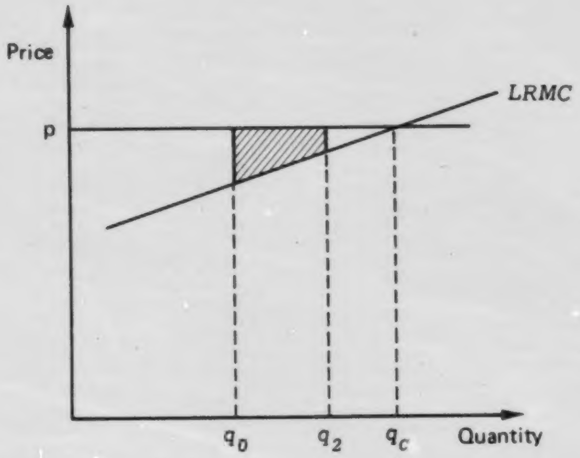

Figure B–3
Losses of Profits for Domestic Firms

$$\text{loss to producers} = \overline{\Delta}LRMC \cdot \Delta q,$$

where $\overline{\Delta}LRMC$ is marginal cost evaluated at full capacity minus marginal cost evaluated at the average of output with and without free trade and Δq is the absolute value of the change in shipments due to free trade.

In percentage change form, the loss to producers is evaluated as

$$\begin{aligned}\text{loss to producers} &= \%\overline{\Delta}LRMC\ \%\Delta q \cdot LRMC_c \cdot q_2 \\ &= \%\overline{\Delta}LRMC\ \%\Delta q \cdot R,\end{aligned}$$

where

$\%\overline{\Delta}LRMC$ = $\overline{\Delta}LRMC$ as a percentage of full capacity marginal cost

$\%\Delta q$ = (absolute value of the) reduction in domestic shipments expressed as a percentage of shipments with trade restrictions

q_2 = domestic shipments in the presence of trade restrictions

$LRMC_c$ = long-run marginal cost evaluated at full capacity

R = value of domestic shipments in the presence of trade restrictions.

We have used the assumption that full capacity long-run marginal cost is equal to the prevailing price. This allows us to substitute price for marginal cost and then substitute revenue for price times shipments.

Deviations in shipments from capacity are calculated by converting rated capacity, measured in tons of production, to tons of shipments. Since production seldom goes above 97 percent of rated capacity, even when demand is heavy, we took 97 percent of rated capacity as actual capacity.

The calculation of the change in marginal cost was based on Katz's research on vintage capital [11]. He found that the elasticity of labor requirements with respect to output was approximately 2. We assumed that other inputs (which we term materials) for marginal plants varied proportionally with output and that both labor and materials had fixed prices. The elasticity of industry cost with respect to output is a weighted average of the elasticity for individual inputs with weights equal to (industry average) factor shares. Using a labor share of 0.38, an elasticity of labor costs of 2, and an elasticity of other costs of 1, the elasticity of total costs with respect to output is 1.38. (The labor share for the year 1971 is taken from [3, p. 13]). If this elasticity is taken as roughly constant when output contracts, the elasticity of marginal cost with respect to output is 0.38. Hence, the percentage change in marginal cost is

$$\%\overline{\Delta}LRMC = \%\overline{\Delta}q \cdot 0.38,$$

where $\%\overline{\Delta}q$ is shipments at full capacity minus the average of shipments with and without trade restrictions. The difference is expressed as a percentage of shipments at full capacity.

The preceding discussion describes a loss of rent to the industry based on the long-run vintage marginal cost curve. In addition, there is a loss due to labor hoarding.

We estimate the quantity of labor hoarded in several steps. The first is to derive desired employment. We take observed annual employment in 1969–73 as a measure of desired employment in the presence of trade restrictions. To derive desired employment without trade restrictions, we adjust these employment figures by the percentage effect of free trade on employment. We use Katz's estimate that the percentage effect on desired employment is twice the output change.

Once the free trade employment figures are derived, they are used to estimate free trade labor hoarding. We assume that, if employment drops between year 0 and year 1, one-half the desired employment reduction is made, the rest being hoarded. If demand drops farther in year 2, the year 1 hoardees are laid off and one-half of the remaining employment decline is made, the remainder being hoarded. (If desired employment had risen sufficiently in year 2, none of the year 1 hoardees would have been laid off.)

These assumptions are used to estimate hoarding in the free trade situation. The cost of hoarding to the industry is the number of workers hoarded multiplied by employment costs per worker, the latter from [3].

The remaining loss from free trade is the earnings loss to workers. The calculation of earnings losses begins with the estimation of layoffs, with and without free trade. Layoffs are the change in employment (after accounting for labor hoarding) minus the amount that can be handled by attrition. We assume that attrition is equal to 1.5 percent of the previous year's labor force.

From layoffs with and without free trade, we estimate the change in layoffs due to free trade. This change is multiplied by Jacobson's estimate of loss in lifetime earnings per laid-off worker to obtain total earnings losses.

In this appendix we have described the calculation of gains and losses to specific groups. The losses are calculated for each group and for each year between 1969 and 1973. These annual figures are then converted to present values as described in the text.

Literature Cited

1. Adams, Walter, and Joel Dirlam. "Steel Imports and Vertical Oligopoly Power." *American Economic Review*, 54 (September 1964), 626-55.
2. ________. "Big Steel, Invention and Innovation." *The Quarterly Journal of Economics*, 80 (May 1966), 167-89.
3. *Annual Statistical Report, American Iron and Steel Institute, 1973*. Washington, D.C., 1974.
4. Armington, Paul S. "A Theory of Demand for Products Distinguished by Place of Production." *IMF Staff Papers* (March 1969), 159-76.
5. *Chartering Annual*. New York: Maritime Research, Inc. Various issues.
6. Corden, W. M. "The Calculation of the Cost of Protection." *Economic Record*, 33 (April 1957) 29-51.
7. Floyd, John E. "The Effects of United States Trade Restrictions on Economic Efficiency." Manuscript prepared for the Department of Labor (ILAB), 1974.
8. ________. "The Overvaluation of the Dollar: A Note on the International Price Mechanism." *American Economic Review*, 55 (March 1965), 95-106.
9. Jacobson, Louis. *Earnings Loss of Workers Displaced from the Steel Industry by Imports of Steel* (PRI 197-75). Arlington, Va.: Public Research Institute, 1975.
10. *Highlights of U.S. Export and Import Trade, August 1974*, U.S. Department of Commerce (FT 990).
11. Katz, Arnold. "Estimates of Labor Displacement: A Structural Approach." *Removing Restrictions on Imports of Steel*, edited by James Jondrow et al., pp. 4-1 to 4-50. PRI 75-2. Arlington: Va.: Public Research Institute.
12. Magee, Stephen. "The Welfare Effects of Restrictions on U.S. Trade." *Brookings Papers on Economic Activity*, No. 3 (1972), 645-701.
13. Stigler, George, and James Kindahl. *The Behavior of Industrial Prices*. New York City: National Bureau of Economic Research, 1970.
14. Thorn, Richard S. "Steel Imports, Labor Productivity and Cost Competitiveness." *Western Economic Journal* (December 1968), 375-84.
15. U.S. Senate, Committee on Finance, Staff Study, 90th Congress, 2d session, *Steel Imports*, 1968.
16. "U.S. Steel Cuts Prices to Fight Import Boom, Dismaying Other Mills." *Wall Street Journal*, May 19, 1968, p. 1.

Comment

Edmund Ayoub

I find much to agree and to disagree with in Mr. Jondrow's study. His time-frame (1969–73) allows him a little complacency about steel import penetration and our ability to adjust to its "gradualness." The facts show a decline in import penetration from 1969 to 1973. However, the peak penetration rate in 1971 was nearly quadruple what it was in 1960. Under some circumstances one might consider import penetration growth from 4.7 percent to 17.9 percent in eleven years as reasonably easily adjusted to. But the adverse job impact of steel import penetration compounded the problem of the secular decline in employment caused by such factors as technological developments and the U.S. industry's significantly declining share of the world market. All told, the job impact takes on a magnitude that justifies our concern about the steel import problem.

Though neither appears to be on the horizon, two developments could mitigate our concern: the achievement and maintenance of a full employment economy, and a strengthening of "fair" trade in world steel.

The author of this paper seeks to determine what the effect of free trade would have been during the 1969–73 period, had we not had the restraints of tariffs and the Voluntary Restraint Agreement (VRA). Briefly, I believe that the period of the investigation is too narrow to allow sufficient perspective on the problem of steel imports. This results in a distortion of the impact of free trade on the U.S. steel industry.

The structure of world steel trade has changed in the post-World War II period. In most countries, steel was an industry that produced mainly for domestic consumption. The postwar rebuilding of new, efficient industries abroad soon resulted in the surfeit of domestic supply in other countries, part of which was exported to the U.S. market. The U.S. share of the world market continued to decline long after the rehabilitation period abroad, when decline was expected and inevitable. Restrictive practices of U.S. trading partners that were established during this rebuilding period have hung on, and now constitute an unfair advantage in trade to the U.S. industry. In other words, the United States might well have a natural comparative advantage in producing steel, but foreign subsidies and trade restrictions have prevented it from being exploited in world trade. In such a situation it is not at all clear that "free trade" in steel is in the U.S. national interest, let alone that of the industry.

Jondrow identifies his time-frame (1969–73) as the period between import penetration (the 1960s) and the period of "reduced threat from imports" (after 1973). Perhaps he is right for the former period, but it is not clear that he is right for the latter period. For one thing, the decline of import penetration since 1973 resulted largely from an "institutional" factor in collective bargaining—the Experimental Negotiating Agreement (ENA). The ENA prevented an industry-wide strike over economic issues, thus communicating to steel-consuming industries that stockpiling was unnecessary. ENA effectively altered the buying behavior of consuming industries. Without ENA, we would surely have had another surge of imports accompanying the 1974 steel negotiations. However, imports rose only moderately, reflecting domestic shortages of particular products and some apprehension over a possible coal strike in late 1974. Thus, by limiting the period of study the author has denied himself a sufficient length of time for an appropriate perspective on the import problem; and he has omitted an important causal factor in the question of import penetration that a broader time-frame would have provided.

There are two cycles in steel that affect output and employment—the "economic cycle" and the "negotiating cycle." They overlap, but their separate effects can be identified, particularly with respect to the initial phases of each. The initial phase of the "negotiating cycle" is particularly pertinent to imports. Jondrow acknowledges the effect of contract negotiations on import penetration. However, it is not treated systematically as a substantive factor in the causal relationship. The data suggest otherwise. They show that import penetration peaked in negotiating years. And the peaks were higher in each successive negotiating year of the 1960s and in 1971—the last negotiating year preceding ENA. The surge of steel buying abroad was most pronounced in the eight to nine months preceding contract termination. This was followed by a sharp drop in output and employment after the contract termination date as inventories were worked off. During the interim years between negotiations, steel imports were sustained at relatively high levels because of consuming industries' familiarity with import purchasing, and long-term contract requirements with foreign suppliers to protect steel buyers from short supplies during the next presettlement cycle. This cyclical pattern did not occur in the 1974 negotiations under ENA.

I do not mean to suggest that import/domestic price differential is not a factor; but it is not a sufficiently complete explanation. It may suggest that steel import purchasing, under certain conditions, is not as price sensitive as one might think a priori. Steel-consuming industries that chose to stockpile in the early stages of the negotiating cycle prior to the 1974 negotiations would probably have purchased imports even without an appropriate price differential. That is a hypothesis that would warrant investigation, by studying price differentials during the high import periods preceding 1965, 1968, and 1971 steel negotiations.

I wish to take exception to another one of the author's assumptions. The Voluntary Restraint Agreement (VRA) is assumed by Jondrow to have restrained trade during most of the period 1969–73. (VRA was in effect for the period 1969–74.) I think that the reverse was true. Without the "restraint" of the quota, less steel probably would have entered our market. VRA provided for an annual quota increase of 5 percent, which is double the average long-run rate of increase in steel demand in the United States. Foreign steel producers sought to garner their quota shares despite shortages of steel in their own countries during part of this period. The long-run benefits of establishing a larger base in the world's largest market are obvious. Without the encouragement of the VRA, the foreign producers might well have supplied their own domestic needs more fully, and the U.S. market might have been spared the alleged benefits of VRA "protection." Voluntary restraint agreements can be useful on a temporary basis for circumventing market disruption; but without a built-in penetration factor.

Is the U.S. industry's period of vulnerability to import penetration over? Jondrow seems to suggest that it is. The time-frame for this study coincided with what he believed to be the peak period of import penetration, at least for several years ahead. Alternatively I have suggested that the ENA played a decisive role in limiting further penetration in the period after 1973.

Market penetration is an important goal of foreign steel producers; once they achieve it, they tend to hang on. Price differentials are a mechanism for penetration. Thus, even if rapidly rising cost factors are working against the comparative advantage of foreign steel producers, I am not fully satisfied that penetration would stabilize or decline. The recent agreement between the EEC and Japan to reduce the latter's exports to the European market has shifted those exports to the U.S. market. Japanese imports rose two million tons in 1976, representing nearly 56 percent of total imports. Moreover, European producers have expressed a desire to restrict steel shipments with one another, while maintaining output levels in the individual countries. If successful, we can expect a rise in European imports of steel to the United States, probably by means of dumping.[1]

The rising level and proportion of imports into the United States over the past decade and a half have cost the steel industry dearly in jobs. A methodology based upon uncertain assumptions and questionable data which leads to conclusions about job loss and the ability to absorb such losses is one I find difficult to accept. We have lost tens of thousands of steel jobs to imports. The loss of income to individual employees is great. In an article published in this volume, Louis Jacobson estimates an earnings loss for displaced steelworkers over a six-year period of about 24 percent, with an average loss for the first two years of over 46 percent. Many cities in this country are largely dependent upon steel for employment. Therefore, entire communities are adversely affected when steel jobs are lost. The tax base deteriorates, retail establishments suffer, and the entire infrastructure of the community is threatened. Adjustments to job losses of such pervasive influence take a long time and are very costly.

The author makes a case for trade liberalization. The effort in these comments is not to argue against trade liberalization. It is to suggest that trade must be a two-way street to be effective; and it must assure reasonable stability in world markets. That foreign imports did not "take over" the U.S. market during the industry's "long period of vulnerability" is no assurance that growing import penetration could not resume and do further damage to U.S. markets and jobs. The least we should be able to expect is a safeguard against market disruption, and some corresponding effort by foreign producers to eliminate trade restrictions in their own markets.

We are faced with a problem of growing national concern. It is inadvisable to allow excessive deterioration of our steel base in this country through further import penetration. We will, at some point, jeopardize national security interests in excessive import displacement of domestic steel production. Steel shortages are expected in the 1980s. If high import penetration discourages sufficient capital investment in new capacity, we could well find ourselves unable to supply our own domestic needs fully. The skilled labor supply that is now being lost because of high imports could well become another bottleneck to expansion later on. These are matters that must also be addressed in evaluating the impact of steel trade in the U.S. market.

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[1] This paper was written in January 1977. The annual rate of EEC imports, based on the first seven months of 1977, amounted to 4.8 million tons, or 49.2 percent above full-year 1976 imports.

Mr. Jondrow has made an effective contribution to the study of trade liberalization in steel; but we must be cautious about drawing premature conclusions about policy implications. A much broader perspective on the issues is essential at this stage.

Comment

Hendrik S. Houthakker

The following comments on the paper by Jondrow et al. deal mostly with chapter 3 on the econometric model. This chapter is of particular interest not only because of its central position in the study and its generally high quality, but also because of the analytical and policy issues it raises. Since many of my comments will inevitably be critical, let me preface them by expressing broad agreement with the approach taken in the study and with the methods by which they were derived. More specifically I endorse the principal finding that removal of steel import restrictions would not lead to a significant decline in domestic employment and that the benefits to the public at large from such removal would outweigh the losses. Indeed I shall argue that the study did not go far enough in identifying the benefits of free trade in steel to the U.S. economy.

The basic model formulated in the beginning of chapter 3 presents no great problems, though disaggregation with respect to product classes or steel-consuming industries might have added to its usefulness (and, to be sure, to the difficulty of estimating it). The first major questions arise on pages 3–9, where it is stated without further explanation that "The estimates are constructed using annual data (1956–73). Equations were also estimated based on quarterly data (1964–1973. II), but they were much less satisfactory and hence are not reported."

Why did not the annual data cover a longer period? Some of the graphs indicate that earlier data were available; since no list of data sources is included, it is difficult to check further into this question. It is important because an adequate number of observations is essential to confidence in any econometric exercise. Considering the large number of variables that have to be considered, eighteen or nineteen observations are decidedly skimpy.

It would also have been illuminating to know more about the problems with quarterly data (and why they were available for less than ten years). Did the quarterly results contradict the underlying economic theory, or were too many estimates statistically insignificant? The author may well have been correct in concentrating on the annual results, but if quarterly data gave a different picture the reader should be told.

Although the analysis of substitution between home-produced and imported steel is competently done, further insight could have been provided by looking at the composition of imports by product classes, which was rather different from the composition of domestic output. Import penetration was greatest in simple products such as reinforcing bars, while the domestic industry, at least until the imposition of quotas, was not seriously threatened in such bread-and-butter products as cold-rolled sheet. The estimated elasticity of substitution between imports and home products may in large part reflect substitution among different product classes, whether on the supply side or on the demand side.

The overall demand equation for steel is much less convincing than the substitution equation. It is not clear that Q as defined by Jondrow is a sufficiently comprehensive measure of activity in steel-consuming industries; where do cans and electric appliances come in, for instance? Moreover one wonders whether Q is really exogenous, considering that it is affected by imports of steel-intensive products such as automobiles. It is also difficult to believe that nonferrous metals are the major substitute for steel, to the extent (assumed in the equation on p. 3–28) that a change in nonferrous prices would have as much impact on steel consumption as an equal percentage change in steel prices. In this equation the elasticity estimate is not very significant and a trend term with a surprisingly large negative coefficient does nearly all the work, casting doubt on the assumption that the coefficient of $\ln Q$ is unity.

With the short-term supply equation (More precisely, the price equation) we come to the crux of the steel industry's problems. Steel executives have long been emphatic in their rejection of price competition as inappropriate for industrial materials. Except for the regulated sector, there is probably no major industry where prices are less responsive to demand fluctuations than in steel, though some discounting from list prices occurs intermittently. This inflexibility of steel prices, to which I shall return below, is confirmed by Jondrow's analysis where the coefficient of capacity utilization is small and barely in excess of its standard error.

In other respects, however, the discussion of short-term price determination leaves something to be desired. The observed leveling-off of steel prices in the 1960s may indeed have been due to imports, but could also have reflected President Kennedy's 1962 intervention and later jawboning by the Council of Economic Advisers, for which steel was the principal target. Furthermore the early and middle 1960s were a period of relative price stability generally. No reference is made to the extensive literature on industrial price equations with its stress on labor productivity (output per manhour); this factor is not adequately captured by the basic-oxygen penetration ratio used by Jondrow as a proxy for technological change. As is true in the other equations, a more precise definition of the variables and their relations to the data would have been in order.

The author makes only modest claims for the remaining two equations of his model, those for domestic capacity and foreign supply, and his modesty is justified. Both the published equations are the result of a long process of trial and error that is not described in any detail. Apparently the capacity problem was approached through the accelerator rather than through profits; again the literature on investment functions is not referred to. It is unfortunate that a more satisfactory capacity equation could not be obtained, for the development of steel capacity is a major puzzle. Since the 1950s only one major new mill has been built in the United States, and none are under construction at present. Many of the existing mills are now obsolete by international standards (and often also by environmental standards), and this may well be the main reason for our steel industry's vulnerability to imports. As far as one can tell, capacity has actually been declining despite some investment in the modernization and expansion of existing plants.

The foreign supply (or export price) equation features a large number of parameters (nine, with only eighteen observations) but even so does not fit the data very closely. Some of these variables could advantageously have been omitted or combined. The most interesting conclusion from this equation is "the strong effect of world demand on the export price," illustrating the radical difference in price flexibility between the world market and the U.S. market. It is also estimated that in 1969–72 the export quotas held imports into the United States down by about 20 percent, a plausible figure that makes one wonder why the quota scheme was pursued with such vigor; surely our market could have absorbed a few million additional tons without seriously affecting the domestic industry.

Notwithstanding the defects of particular equations, the model of chapter 3 is acceptable as a first approximation: the whole is better than the parts. I shall not comment on the projections for 1974–78, since the assumptions on which they are based appear to have been unrealistic; apparently the macroeconomic forecasts used for this purpose did not anticipate the severity of the 1974–75 recession. In 1975, for instance, domestic shipments were only 80 million tons compared to the projected 102 million tons, and imports were also well below the projections. An updating of these projections would clearly be desirable.

Space does not permit detailed comment on the other chapters. In chapter 4 of the underlying research report that was summarized in Jondrow's paper, Arnold Katz grapples imaginatively, but in the end inconclusively, with the well-known conundrum of increasing returns to labor in the short run. Some of his work on the production function could be integrated into the overall model of chapter 3. The analysis of displacement losses in chapter 5 is extremely detailed and apparently complete; whether it will convince the unions is another matter. Chapter 6, a sophisticated discussion of surplus measurement, is somewhat out of place in this generally down-to-earth study.

Chapter 7 deals mostly with the suitability of basic-oxygen penetration as an indicator of cost differences; not surprisingly it does not come to a definite conclusion. The fact is that there have been important technological changes unrelated to BOF, but these are never mentioned. Examples are continuous casting, which dispenses with the labor-intensive blooming mill, and computerization of rolling mills; the ever-increasing size of blast furnaces and the pretreatment of ores can also have a significant effect on cost. The tendency throughout the report to identify technological change with the basic-oxygen furnace detracts from its usefulness as a contribution to steel industry economics.

In conclusion I return to the question of price flexibility as it is affected by imports. The industry's abhorrence of price competition goes back many years, at least to Judge Elbert Gary (1846–1927) who, frustrated in his plans to turn U.S. Steel into a monopoly, enjoined the successor firms to "live and let live." In effect, the steel industry behaves like a cartel, though this does not necessarily mean that its practices are illegal. (The historical argument for this industry's adherence to full-cost pricing, namely large fixed cost, is incidentally contradicted by the report, which puts variable cost at 87 percent of total cost.)

This harmony among potential rivals was threatened when imports became competitive in the 1950s. The exporters did not belong to the U.S. informal cartel and they were not used to inflexible prices. Although the European and Japanese steel industries are hardly examples of perfect competition, substantial price fluctuations in response to changes in demand do occur. The American industry was concerned not only because of the loss of business, but also because its pricing practices became vulnerable. This is one of the reasons why imports were ultimately controlled by quotas rather than tariffs; import quotas reinforce a domestic cartel, while tariffs (unless prohibitive) encourage price flexibility.

The federal government under Presidents Johnson and Nixon was only too willing to negotiate "voluntary" export quotas, following a pattern already laid down in textiles and meat. Foreign steel industries were prepared to cooperate because export quotas permitted them to charge higher prices in the United States. As far as revenue is concerned, an export quota is equivalent to a duty collected by the exporting industry (not, be it noted, by the exporting country). By making the quota "voluntary," compensation under the General Agreement on Trade and Tariffs rules was avoided.

Were these arrangements in the public interest? Although the voluntary quotas have lapsed, the question is not merely of academic interest, for any future protection given to our steel industry may well be on similar lines. In my opinion the answer is clearly no. Inflexible prices are contrary to economic efficiency both in a microeconomic and a macroeconomic sense. Microeconomically, because cartel-like pricing practices tend to keep inefficient firms in operation; there have been very few bankruptcies in this stagnant industry where the efficient firms have apparently refrained from expansion (especially through new plants) for fear of upsetting the established market pattern. As a result both the profitability and the productivity performance of the steel industry have been below average.

Even more serious is the macroeconomic effect of inflexible prices (more precisely, of prices that are determined primarily by cost and bear little relation to demand conditions). When prices are inflexible, changes in demand are immediately translated into changes in output, and ultimately in employment. Thus if demand in an important industry (such as steel) weakens, its customers are not given any incentive to buy more, especially for inventory. The fall in output and employment brings stimulative fiscal and monetary policies into action, with their attendant inflationary pressures. Inadequate price flexibility in major industries — steel is not an exception, just an extreme case — therefore contributes powerfully to the combined inflation and unemployment that has increasingly plagued us in recent years. Furthermore, the low levels of investment implicit in cartel-like pricing deprive the economy of needed stimulus from the private sector.

The removal of import restrictions on steel, therefore, has an importance well beyond the industry immediately affected. As the report shows, the disruptive effects of such liberalization would be minor in any case. Among its benefits, considerable weight should be given to the invigorating force of price competition, which could give our steel industry the dynamic role in our economy it had many years ago.[1]

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[1] In this connection it is unfortunate that the report has little or nothing to say about steel exports, which have been significant even in some recent years (in 1970 and 1973 exports were about half the size of imports). A less hidebound pricing and investment policy might well make our industry into a sizable exporter of certain products.

Reply

James M. Jondrow

Though agreeing broadly with the general approach and findings of the study, Professor Houthakker makes a number of specific comments on the estimation of the model.

One is on the limited number of annual observations. This comment is applied specifically to the import supply equation. Though more observations are clearly better than fewer, a large number of observations is not necessary for precision of estimation. Most of the parameters of interest in the model have significant coefficients, even when degrees of freedom are taken into account. A necessity for reliable estimation is variation in the independent variables, and this variation was available for most of our time series. Furthermore, by using a short sample period one avoids some of the difficulties associated with structural change that may affect long-term estimates.

One possibility for increasing the sample size, as Professor Houthakker mentions, is quarterly data. Our sources for quarterly data did not extend back as far as for the annual data. Furthermore, though quarterly data increased the number of observations, there was actually less variation in the independent variables over the shorter number of years and there was apparently random variation in the dependent variables. In the quarterly model, these problems led to imprecise estimates of substitution between domestic and imported steel. Estimates of the elasticity of substitution had high standard errors and were not robust to even minor changes in the specification of the equation. In contrast, results based on annual data over a longer span of years were more precise and robust.

Professor Houthakker finds the demand for steel equation less convincing than the substitution equation. The latter is much more important in evaluating the effect of imports. He questions the use of the nonferrous price as the price of substitute materials in the demand for steel equation. Yet results using the wholesale price index for all commodities as reported in the paper were much the same. This robustness is desirable since there is no obvious best measure of the price of substitutes.

His main comment on the short-term price equation is that there are other explanations besides imports for the leveling off of steel prices in the 1960s. We agree. Indeed our empirical work found that the leveling of the steel price during the 1960s could be explained by a leveling of input prices. But other factors might also be involved.

An estimated capacity equation was reported in the research report on which our conference paper was based. The equation turned out to be unimportant, and was dropped. Still, as Professor Houthakker comments, an equation explaining capacity formation would be very useful. We agree. In fact, our findings on the subject seem plausible. Output is a strong determinant of capacity when corrected for cyclical variation and substitution between capacity and other inputs is limited.

Effects of Trade Barriers on The U.S. Automobile Market

Eric J. Toder with N. Scott Cardell*

1. Introduction

This paper summarizes some of the principal findings of a study performed at Charles River Associates [6], which assessed the benefits and costs of potential trade policy changes affecting the U.S. automobile industry. We focus here on the determinants of changes in U.S. automobile imports, with particular emphasis on the effects of trade policies that alter the price of imported automobiles on import new car shares and on domestic automobile industry output.

The fraction of new car sales in the U.S. market accounted for by imports, which was less than 1 percent until the late 1950s, reached a peak of 20 percent in early 1975. The growth of the import share in 1974 and 1975 coincided with a decline in the total U.S. automobile new car market accompanying the 1974 oil embargo and subsequent fuel price increases and the 1974–75 recession. In 1976, the import share of new car sales fell significantly as the U.S. auto industry experienced a strong recovery.

The growth in imports that accompanied the 1974–75 decline in U.S. automobile industry output and employment led to some discussion of the use of tariffs and/or quotas to increase domestic automobile industry employment by reducing imports.[1] The current U.S. import tariff on finished automobiles is only 3 percent,[2] much lower than the tariffs imposed by other major producing nations. An increase in the tariff would reduce imports both by encouraging U.S. consumers to substitute U.S.-manufactured automobiles for automobiles currently imported and by encouraging foreign manufacturers to shift production facilities to the United States.

In the past twenty years automobile imports have occupied a special niche in the U.S. market; they have generally been lighter, less powerful, and more fuel-efficient than automobiles manufactured in the United States. The analysis in this paper views imported automobiles as a separate product that is a close, but not a perfect, substitute for U.S.-made automobiles. Differentiation in consumer tastes and the existence of important scale economies in automobile production together explain how it is possible for the United States to import large numbers of automobiles even if the United States has a comparative advantage in production at minimum efficient scale. Manufacturers producing automobiles at or above minimum efficient scale in Europe (Japan), which are designed to be optimal for majority European (Japanese) consumer tastes and highway conditions, can potentially undersell U.S.

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*The research for this paper was performed while the principal author was employed at CRA for a report prepared under contract to the U.S. Department of Labor, Bureau of International Labor Affairs. James C. Burrows provided overall supervision for the preparation of the original report. The authors are indebted to both Dr. Burrows and to Zvi Griliches for valuable guidance and advice throughout the preparation of the study and for comments on preliminary written drafts. Harry Grubert of the U.S. Department of Labor and Mike Luckey of the U.S. Motor Vehicle Manufacturers Association also reviewed earlier drafts of the report and contributed many useful suggestions. The hedonic market share model of automobile demand referred to in the paper was developed by N. Scott Cardell. Many other members of the CRA staff contributed to the original report. This paper is based on Charles River Associates "Impact of Trade Policies on the U.S. Automobile Market," ILAB 74-19 which was released as an ILAB/OFER Discussion Paper on International Trade, Foreign Investment, and Employment in 1976.

[1] For example, the United Automobile Workers (UAW) in 1975 suggested "harmonization" of U.S. duties with duties imposed by the Common Market. The UAW position in effect amounted to advocacy of a U.S. tariff increase, at least until the Europeans agree to lower their rates. UAW also believes that U.S. jobs in the automobile industry are being lost because of imports of autos at less than fair market value. A recent U.S. Treasury Department investigation to determine whether foreign auto companies are in fact violating anti-dumping regulations has been terminated with a decision to take no action, possibly because Volkswagen has just announced plans to build an assembly plant in the United States.

[2] The base to which the tariff is applied is based on an estimate of the sum of foreign production cost plus an assumed profit markup, which is lower than the sales price of imports, net of tariff. Thus, the effective tariff rate as a fraction of the price of an imported automobile is somewhat lower than 3 percent.

companies in segments of the market where U.S. demand is too small to support optimal scale output, even if the United States has a production cost advantage at optimal scale.

The empirical findings presented in this paper address two separate questions: (1) the effect of relative price changes on the market share in the United States of automobiles currently produced in Europe and Japan; and (2) the effect of tariffs and future market trends on the *location of production* of automobiles that are currently imported to the United States. The former question is examined using several techniques of demand analysis, and the latter is examined by piecing together available statistical evidence on relative factor prices, material input prices, and motor vehicle industry labor productivity in the United States, Japan, and West Germany, costs of shipping automobiles to the United States from Europe and Japan, and percentage cost penalties for producing automobiles at levels of annual output below minimum efficient scale.

The principal finding from the demand research is that domestic and currently imported automobiles are good, but not perfect, substitutes. Application of both conventional time series analysis and a new method of estimating demand for differentiated durable goods provides econometric estimates which imply that a 1 percent increase in the ratio of imported to domestic new car prices would lead to about a 2 percent reduction in the ratio of imported to domestic new car sales. The long-run elasticity of substitution between domestic and imported new cars is shown to be higher in some specifications of the demand equations.

Comparison of relative costs of inputs to the automobile industry in different countries, using weights from an input-output table, reveals that in 1974 production of automotive industry products at efficient scale was about 17 percent less expensive in Japan, and about 9 percent more expensive in West Germany than in the United States. Adding transport cost estimates to estimated foreign production costs makes the supply cost to the United States 3 percent higher for automobiles produced in Japan and 15 percent higher for automobiles produced in West Germany than for automobiles produced in the United States.

The best available evidence shows that economies of scale are very important in the production of automobiles. Production below optimal scale leads to substantial per-unit cost penalties, especially for smaller cars. It appears that an annual output rate of 400,000 units is sufficient to attain most economies in small car production.

At current levels of U.S. sales of major Japanese imports, the supply cost to the United States is lower for production in Japan than for production in the United States.[3] However, the data indicate that the supply cost of Volkswagens to the U.S. market would be lower if Volkswagens were produced in the United States. Volkswagen's recent decision to establish production facilities in the United States is consistent with the implications of the analysis.

The findings from the comparative product cost analysis suggest that there may be a large potential market in Europe for U.S.-manufactured automobiles if E.E.C. auto import tariffs are lowered. This finding is consistent with the results of research on comparative truck prices, which suggest that U.S. heavy trucks could also compete favorably in the West German market if E.E.C. tariffs were lowered (see [4]).

The remaining sections of this paper detail the research methodology and principal findings. Section 2 provides estimates of the effects of import price changes on the import share demanded, using time series analysis, cross-section analysis, and a new market share demand model developed for this study. The market share demand model is discussed in more detail in an appendix. Estimates are provided of the likely effect of tariff increases on domestic and imported new car sales in the absence of a shift in production location of individual automobile models. Section 3 reviews the available evidence on the shape of automobile production cost curves and outlines the methodology used to compare automobile production costs in different countries. Sample simulations are presented showing how tariff changes may affect production location. In section 4, we review the principal findings and examine the implications for the U.S. automobile market in the next few years.

2. Effects of Auto Import Price Changes on Import Shares and Domestic Prices

One major effect of higher import tariffs is to increase the price of imported automobiles by increasing the cost of selling in the United States automobiles that are produced abroad.[4] An increase in the price of imported autos means that both the price ratio of imported to domestic new cars and the average price of all new cars sold in the market will rise. An increase in the relative price of imports will lead consumers to substitute imported new cars for domestic new cars; a rise in the average price of all new cars will lead to a decline in new car sales, as consumers keep their old cars for longer periods of time. A rise in the price of imported automobiles may lead to an increase in domestic prices in response to a lessening of competitive pressures.

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[3] As the same vehicles are being produced in Japan for the local market, minimum efficient scale can be attained even for low levels of U.S. sales. If sales of Japanese imports continue to grow along past trend lines, it may be more economical to produce Toyota and Datsun in the United States in a few years.

[4] If other tariff and/or fiscal/monetary policies keep exchange rates and relative rates of inflation constant, and if foreign and domestic manufacturers are both on horizontal long-run supply curves, then the percent increase in foreign car prices will be equal to the absolute increment in the ad valorem tariff rate.

In this section, we provide econometric estimates of the effect of changes in the ratio of imported to domestic automobile prices on the ratio of imported to domestic new car sales. We combine these estimates with the results of previous econometric research on the demand for automobiles to obtain rough estimates of the effect of import price increases on domestic sales.

Most previous research on automobile demand has focused on estimating equations for total sales which do not distinguish among types of car purchased. The literature on total demand for automobiles is extensive, but much less work has been done on modeling changes in market shares by type of car sold. Much of the research on automobile market share has been unsuccessful in obtaining estimates of price effects that are consistent with economic theory.[5]

The relative price elasticity of import share demand is estimated here using three different methods: (1) time series analysis, (2) cross-section analysis, and (3) a new technique referred to as the "hedonic market share model." The principal findings from each approach, together with the data and methodology used and some of the problems of interpretation are discussed below.

Time Series Analysis of Import Share Demand

For the time series analysis, we defined two composite goods, imported automobiles (F) and domestic automobiles (D). Using data for the years 1960–74, we estimated equations of the form

$$\log\left(\frac{F}{D}\right)_t = a + b \log\left(\frac{F}{D}\right)_{t-1} + c \log\left(\frac{P_F}{P_D}\right)_t + d \log X_t, \qquad (1)$$

where $(F/D)_t$ is the ratio of import to domestic new car sales in year t, $(P_F/P_D)_t$ is the ratio of price index of import to domestic automobiles in year t, and X_t is a vector of exogenous variables, which included, in different specifications, per capita disposable income, per capita disposable income divided by per capita disposable income of the previous year, the price of gasoline, and a time trend variable.

The price indices for imported and domestic automobiles were created from regressions for adjacent years of prices of individual models, both imported and domestic, on physical characteristics and a time dummy. Estimates of one-year-old transactions prices reported in past issues of the automobile *Red Book*, published by National Market Reports, Inc., were used as a proxy for new car transactions prices. The alternative of using new car list prices was rejected because previous researchers have shown that the relationship between transactions prices and list prices of new cars have varied widely over time.[6] One-year-old transactions prices are not an ideal proxy for new car prices either; the ratio between new car transactions prices and one-year-old transactions prices will change if the market is in disequilibrium. Despite these problems, our estimated price index for domestic cars mirrors closely the BLS index of new car prices since 1960.[7]

Equation (1) was also estimated using a composite index for relative first-year ownership cost of imported to domestic automobiles in place of the relative price index. The composite cost indices for imported and domestic automobiles were computed by combining the price indices with indices of annual gasoline costs for domestic and foreign automobiles, using weights of 0.65 for selling price and 0.35 for annual gasoline costs. In deriving the weights, we assumed a 20 percent depreciation rate in the first year, a 5 percent interest rate, a gasoline price of $0.55 per gallon, and 10,000 average annual miles driven. The gasoline cost index was computed by dividing a gasoline price index (supplied by

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[5] Cowling and Cubbin [10] estimated a negative relationship between market shares and quality-adjusted prices (where the "quality-adjusted" price is the residual from a hedonic price equation) using time series data from the United Kingdom for 1956–68. The Cowling and Cubbin model estimated firm sales as a function of lagged sales, the "quality-adjusted" price, and advertising expenditures; their findings implied a short-run price elasticity of individual manufacturers' demand of −1.9497, and a long-run price elasticity of −7.06. However, Triplett and Cowling [23], using a similar model with United States data, were unable to detect a negative relationship between changes in individual manufacturers' market shares over time and changes in the residuals of hedonic price regressions.

Recent interest in designing policy instruments to increase the fuel economy of the automobile stock has motivated research to estimate demand for different size classes of automobiles. Research efforts in this direction have been handicapped by the difficulty of finding significant differences across time or across geographic areas in the quality-adjusted price of automobiles of different size classes. For examples, see [3,12,7].

[6] In addition, relative discounts on foreign and domestic models have not been constant over time. For a history of list prices and transactions prices of U.S. autos in the early post-war years, see [24].

[7] The BLS index is constructed from surveys of transactions prices of selected models in a number of cities and is heavily weighted towards domestic automobiles, though Volkswagen is included as one of the models. BLS does not publish separate indices for domestic and imported automobiles.

BLS) by a mileage index. Mileage indices for domestic and imported automobiles were computed [1] from historical estimates of mileage for automobiles of different weight classes.[8]

Table 1 shows that the relative price index and the relative composite cost index both showed significant fluctuations in the sample period. The two indices practically mirror each other, with the relative composite cost index lower because of the superior fuel efficiency of imported cars. The relative price index of foreign cars rose faster than the relative composite cost index of foreign cars between 1973 and 1974, the year of the big gasoline price increase.[9]

The major problem with estimating a relative price elasticity of import share demand from the time series approach is that fluctuations in the quality-adjusted ratio of domestic to imported car prices, although clearly detectable, have been small relative to other changes that have influenced import shares. Some of these changes are not easily quantifiable; they include changes in the availability of close domestic substitutes for imports, the growth in imported car dealer networks with its consequent spread of information and reduction of servicing costs, changes in the available variety and quality of foreign models, especially since the introduction of Japanese cars in the late 1960s, and changes in environmental and safety regulations, which have impacted new car purchase prices and fuel costs.

Despite problems of model specification and difficulties in data construction, we found strong evidence of a significant price effect on import shares. Sample results from time-series equation estimates for the years 1961–74 are shown in Table 2.[10]

The equations are estimated by generalized least-squares; the value of ρ, the serial correlation coefficient, was selected by trial and error to minimize the standard error of estimate.

The coefficient of *FDPRICE*, the ratio of imported to domestic quality-adjusted auto prices, is the short-run elasticity of relative import demand with respect to relative import price. The long-run elasticity is equal to the short-run elasticity divided by $(1\text{-}m)$, where m is the coefficient of lagged sales. The long-run elasticity is high relative to the first year's response when the coefficient of lagged sales is large.

Table 1

Comparison of Imported to Domestic Car Relative Price and Total Cost Indices, 1960–74

Year	Import to Domestic Price Ratio	Import to Domestic Gas Cost Ratio	Import to Domestic Composite Ratio
1960	1.099	0.608	0.985
1961	0.971	0.473	0.853
1962	1.011	0.535	0.907
1963	1.001	0.517	0.881
1964	0.930	0.566	0.851
1965	1.098	0.517	0.949
1966	0.953	0.589	0.860
1967	0.902	0.535	0.807
1968	0.963	0.622	0.874
1969	1.013	0.536	0.885
1970	1.018	0.513	0.865
1971	1.119	0.518	0.947
1972	1.054	0.483	0.890
1973	1.000	0.454	0.832
1974	1.217	0.542	0.981

Source: [6, Table 3-8].

The implied long-run and short-run relative price elasticities from equations (2–1) through (2–6) are reported in Table 3.

From Table 3, it can be seen that the short-run relative price elasticity is fairly stable with respect to changes in specifications; it varies between −0.945 and −1.754. However, the long-run elasticity is very sensitive to specification changes because of the instability of the coefficient on lagged relative sales; it ranges from a low of −1.436 to a high of −18.253. The lower long-run elasticity estimates are for equations including the variable *JAPAN*. *JAPAN* is a trend variable that picks up the sharp growth in import shares after 1965; this growth coincided with the introduction of popular Japanese imports beginning in 1966. The coefficient of Japan in equations (2–2) and (2–5) shows an annual growth rate of approximately 10 percent in the import sales ratio after 1965, which is independent of all other explanatory factors.[11]

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[8] For details of the construction of the hedonic price indices and relative composite cost index, respectively, see [6, Appendixes 3–A and 3–B].

[9] Although the fuel efficiency of imported autos relative to domestic autos worsened between 1973 and 1974, the fuel price increase still helped the relative competitiveness of imports, since their fuel efficiency, though worsening, remained superior to the fuel efficiency of domestic cars.

[10] The same equations were also estimated for the sample period 1961–73 to correct for any special effect that might have been caused by the 1973-74 oil embargo and subsequent gasoline price increase. Estimation for both sample periods yielded qualitatively similar results. See [6, Table 3–10].

[11] *JAPAN* measures a growth trend in the import share between 1966 and 1974 which is not adequately explained by other variables. If the equation is to be used for forecasting purposes, it is clearly inappropriate to extrapolate equations including *JAPAN* in future periods.

Efforts to find a more satisfactory quantifiable variable to explain the 1966–74 growth trend to the import share were unsuccessful. For a full discussion see [6, chap. 3 and Appendix 3–C].

Table 2

Import Share Demand Estimates: Time Series Equations (1961-74)

Equation (2–1)

$$\text{Log}(FDSALE) = \underset{(0.012)}{0.00140} + \underset{(10.078)}{0.917}\,\text{Log}(FDSALE_{-1}) - \underset{(3.405)}{1.515}\,\text{Log}(FDPRICE) + \underset{(3.450)}{0.882}\,\text{Log}(INCOME)$$

$$R^2 = 0.9509 \qquad \rho = -0.130$$

Equation (2–2)

$$\text{Log}(FDSALE) = \underset{(1.518)}{0.202} + \underset{(1.349)}{0.347}\,\text{Log}(FDSALE_{-1}) - \underset{(2.968)}{1.166}\,\text{Log}(FDPRICE) + \underset{(1.539)}{0.423}\,\text{Log}(INCOME) + \underset{(2.383)}{0.107}\,JAPAN$$

$$R^2 = 0.9615 \qquad \rho = 0.030$$

Equation (2–3)

$$\text{Log}(FDSALE) = \underset{(0.227)}{0.0282} + \underset{(8.055)}{0.875}\,\text{Log}(FDSALE\quad) - \underset{(3.252)}{1.754}\,\text{Log}(FDPRICE) + \underset{(3.282)}{1.017}\,\text{Log}(INCOME) - \underset{(1.149)}{2.404}\,\text{Log}(RELINC)$$

$$R^2 = 0.9468 \qquad \rho = 0.016$$

Equation (2–4)

$$\text{Log}(FDSALE) = \underset{(0.604)}{0.0638} + \underset{(8.506)}{0.814}\,\text{Log}(FDSALE_{-1}) - \underset{(3.967)}{1.895}\,\text{Log}(FDCOST) + \underset{(4.010)}{1.036}\,\text{Log}(INCOME)$$

$$R^2 = 0.9576 \qquad \rho = 0.100$$

Equation (2–5)

$$\text{Log}(FDSALE) = \underset{(1.799)}{0.223} + \underset{(1.417)}{0.342}\,\text{Log}(FDSALE_{-1}) - \underset{(3.262)}{1.454}\,\text{Log}(FDCOST) + \underset{(1.947)}{0.572}\,\text{Log}(INCOME) + \underset{(2.175)}{0.0939}\,JAPAN$$

$$R^2 = 0.9646 \qquad \rho = 0.068$$

Equation (2–6)

$$\text{Log}(FDSALE) = \underset{(0.977)}{0.108} + \underset{(6.773)}{0.742}\,\text{Log}(FDSALE_{-1}) - \underset{(4.177)}{2.279}\,\text{Log}(FDCOST) + \underset{(4.205)}{1.242}\,\text{Log}(INCOME) - \underset{(1.620)}{2.894}\,\text{Log}(RELINC)$$

$$R^2 = 0.9592 \qquad \rho = 0.047$$

(t–statistics are in parentheses in all equations)

Variable Definitions (and Sources)

FDSALE = ratio of foreign to domestic new car sales (*Automotive News Almanac*, successive issues)

FDSALE$_{-1}$ = ratio of foreign to domestic new car sales in previous year

FDPRICE = ratio of imported car price index to domestic car price index [6, Table 3-7; derived from hedonic regressions]

FDCOST = ratio of imported car composite cost index to domestic car composite cost index [6, Table 3-8]

INCOME = real per capita disposable personal income (*Economic Report of the President*, 1975)

JAPAN = Dummy variable for number of years since mass entry of Japanese imports; before 1965 = 1, after 1966 = year − 1965 + 1

RELINC = ratio of per capita disposable income to per capita disposable income of previous year

Table 3

Implied Short-Run and Long-Run Relative Price Elasticities from Time Series Equations for Import Share Demand

Equation	Short-Run Elasticity*	Long-Run Elasticity*	Price Variable	Other Independent Variables
2–1	−1.515	−18.253	*FDPRICE*	*INCOME*
2–2	−1.166	− 1.786	*FDPRICE*	*INCOME, JAPAN*
2–3	−1.754	−14.032	*FDPRICE*	*INCOME, RELINC*
2–4	−1.232	− 6.624	*FDCOST*†	*INCOME*
2–5	−0.945	− 1.436	*FDCOST*†	*INCOME, JAPAN*
2–6	−1.481	− 5.740	*FDCOST*†	*INCOME, RELINC*

$$\text{Long-run elasticity} = \frac{\text{Short-run elasticity}}{1 - (\partial \log[FDSALE]/\partial \log[FDSALE_{-1}])}$$

*Elasticity of foreign to domestic sales ratio with respect to foreign to domestic price ratio.

†Where *FDCOST* was used as the price variable in an equation, the formula

$$\frac{d\log(FDSALE)}{d\log(FDPRICE)} = \frac{d\log(FDSALE)}{d\log(FDCOST)} \cdot \frac{d\log(FDCOST)}{d\log(FDPRICE)}$$

$$\approx 0.65\,\frac{d\log(\mathrm{FDSALE})}{d\log(FDCOST)}$$

was used to translate the elasticity of import share with respect to relative inclusive cost into an estimated elasticity with respect to relative sales price.

The very high income elasticities reported in equations without the variable *JAPAN* suggest that income may be acting in part as a proxy for time trend in those equations. Where the post-1965 time trend variable is included, the income elasticity is lower, though still positive. The positive income coefficient indicates that imports may be viewed as a luxury good,[12] a finding confirmed by cross-section evidence reported below. On the other hand, the negative coefficient on *RELINC*, the ratio of income to income of previous year, in equations (2–3) and (2–6), shows that import shares tend to *rise* during recessions. This result does not necessarily contradict the view of imports as "luxury" cars; recessions appear to affect the sales of low-priced domestic automobiles much more than luxury domestic automobiles because the auto buying of the very wealthy is less affected by temporary economic declines.[13]

In conclusion, the time series equations show significant price substitutability between domestic and imported cars, despite problems in defining an appropriate price variable and explaining with quantifiable economic variables the trend growth in import shares between 1966 and 1974. Differences in estimates of the lag coefficient cause the estimates of the long-run effect of a relative price change to be somewhat imprecise. Where a trend variable is included in the equations, the long-run relative price elasticity of the import-to-domestic sales ratio is slightly under −2.

Cross-Section Analysis of Import Share Demand

The cross-section equations estimated use observations of the ratio of imported to domestic new car sales in individual states in 1974. Data on differences in transactions prices of new cars in different states were not available. Estimates of the relative price of imported to domestic automobiles in individual states were constructed by adding freight charges in different states[14] to list prices of "representative" domestic and imported models. Freight on imported automobiles is lowest on the east and west coasts and highest in the middle of the country, and freight charges on domestic autos are lowest near Detroit and highest on the two coasts. Thus, the estimated relative import price is highest in the Middle West and lowest on the East Coast and the West Coast. The import share of new car sales is highest in states along the two coasts and lowest in the Middle West states.[15]

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[12] Even though imported autos are less expensive than domestic autos, on the average, they may be a luxury good if imported cars are purchased disproportionately by families owning more than one car. For evidence from consumer survey data that, in the recent past, buyers of new imported cars have been higher income consumers than buyers of new American cars, see [17].

[13] For example, in the 1974–75 recession sales of Buick and Cadillac actually increased along with sales of most imports, while sales of domestic compacts and subcompacts declined by over 30 percent. See [6].

[14] Freight was computed from port of entry for imports and from Detroit for domestic autos. The freight "included" in the sticker price of imports is computed from the nearest port of entry regardless of the origin of the automobile; thus, freight on a Japanese car sold in New Jersey is computed from New York, not from California.

The relationship between the import-to-domestic sales ratio and the import-to-domestic price ratio, with other determinants of the sales ratio taken into account, is shown in equation (2)

$$
\begin{aligned}
\log(FDSALE) = {} & 63.424 - 18.188 \log(FDPRICE) \\
& (6.156) \quad (8.643) \\
& + 1.845 \log(PC2029) \\
& \quad (2.992) \\
& + 0.271 \log(PCAPI) \\
& \quad (0.910) \\
& + 1.490 \log(PGAS) \\
& \quad (0.971)
\end{aligned}
$$

(t-statistics are in parentheses)

$$R^2 = 0.7102 \quad F(4,42) = 25.745, \tag{2}$$

where FDSALE is the ratio of imported to domestic new car registrations, *FDPRICE* is the ratio of estimated average delivered list prices of new imported cars to average delivered list prices of new domestic cars, *PC*2029 is the percent of population between ages twenty and twenty-nine, *PCAPI* is 1973 per capita income, and *PGAS* is the price of gasoline.[16]

The relative price elasticity of the import-to-domestic sales ratio estimated in equation (2) is −18.188, a value approximately equal to the highest value of the long-run elasticity estimated in the time series equations in Table 2. The import-to-domestic sales ratio is also positively correlated with the percentage of the population aged twenty to twenty-nine, per capita income, and the price of gasoline. In other specifications of the equation, we found no significant statistical relationship between the import-to-domestic sales ratio and the percentage of population in urban areas, the percentage of population residing in U.S. census-defined Standard Metropolitan Statistical Areas (S.M.S.A.s), and the median education level of the population. We also estimated equations omitting Michigan and other auto-producing areas; these omissions had little effect on the results.[17]

Both theoretical considerations and comparison with the time series results suggest the possibility that the absolute value of the price elasticity estimated in equation (2) is biased upwards. Low foreign car sales in states with higher relative foreign car prices may in part reflect the reluctance of some consumers to purchase automobiles that are not locally popular and for which adequate service facilities are not available. In other words, the relevant price variable for buyer decisions on imported car purchases, which includes both selling price and money and time costs of repair and maintenance, may be systematically higher in states with lower imported car sales. Thus, small differences in desired purchases caused by price differentials may be magnified by availability problems in the states with somewhat higher prices. If so, the differences in foreign shares across states associated with differences in relative prices may provide too high an estimate of the nationwide change in sales that would occur in response to a small change in the foreign-to-domestic price ratio.

It is also possible that other factors, possibly patriotism, could be causing the relatively higher domestic sales in the Midwest. However, the data do not reveal any obvious correlation between political attitudes and/or related socioeconomic variables (such as the rural/urban population mix) and imported auto shares.

In conclusion, the cross-section estimates show a very high price elasticity of substitution between domestic and foreign-made automobiles. For the reasons noted above, the cross-section results are viewed as upper-bound estimates of the price elasticity.

Hedonic Market Share Model of Import Share Demand

The hedonic market share model is a new technique of demand analysis that is used here to provide an alternative set of estimates of the impact of changes in imported car prices on the import share of new car sales. The technique yields general predictions of the effects of changes in prices and characteristics of any set of automobile models on the market shares of individual models. The predictions of the share changes for individual models are then summed to obtain the predicted change in the share of a class of models resulting from any price changes.[18]

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[15] For a fuller description of how the price data were constructed and for tables showing import shares and estimated domestic and imported auto freight charges in different states, see [6, chap. 3, sec. F].

[16] *FDSALE* was constructed from data in *Automotive News Almanac*, 1975, and *FDPRICE* was constructed from data on average list prices from *Automotive News Almanac*, 1975; data on import freight charges were supplied by Volkswagen of America. The data sources for the other variables were: *PC2029*, *Census of Population*, 1970, *General Population Characteristics-United States Summary; PCAPI*, *Survey of Current Business*, April 1974; *PGAS*, *Platt's Oil Price Handbook and Oilmanac*, 1974.

[17] It may be argued that 1974 was an unusual year because of the oil embargo and the subsequent increase in the price of gasoline. However, estimates of the price elasticity from an analogous set of cross-section equations using 1973 data yielded almost identical results. See [6, chap. 3, sec. F].

The hedonic market share model was developed for this study primarily because use of conventional demand methods cannot fully record the main elements determining market share demand for broad classes of automobiles, even if totally accurate price data are available. The principal problem in applying time series and cross-section approaches is the necessity to view each group of automobiles as a single, composite good with an identifiable price. Both changes in the range of automobiles available within each group and changes in the extent to which a typical automobile within each group has characteristics that appeal to a large fraction of buyers cannot be modeled readily within the conventional framework.

The hedonic market share model is designed specifically to account for changes in the substitutability among automobiles in the two groups. It does this by viewing each automobile as a bundle of characteristics, and estimating the distribution of buyers' tastes for the separate characteristics. The model represents both an application of recent theoretical work on consumer demand theory and an extension of models used in analogous empirical research on mode choice in urban transportation.[19]

The main idea behind the hedonic market share model is simple, though its details are complex. Demand for automobile characteristics, including price, is assumed to vary among individual consumers because of differences in income, use patterns, and personal tastes. A consumer, in purchasing an automobile, is rejecting alternative models with slightly different characteristics and price; by examining the characteristics and price of the model chosen and the models rejected, it is possible to place bounds on the marginal rates of substitution among characteristics and price in the consumer's utility function. If market coverage is reasonably complete, data on market shares and characteristics (including price) of all models can be used to estimate a distribution of consumer taste parameters, where the taste parameters reflect the marginal utility to consumers in dollar terms of additional amounts of the different characteristics. For any given set of available models, with known prices and characteristics, the market shares can be predicted if the distribution of the consumer taste parameters is known.

The input data used in the model are the price, selected characteristics, and new car sales in a given time period of a set of automobile models.[20] The characteristics include available attributes that either contribute to, or are correlated with, the quality of a car. Available characteristics data for recent years include both physical dimensions reported in *Automotive News Almanac* and performance data collected by the U.S. Department of Transportation and the U.S. Environmental Protection Agency. The physical characteristics data include number of cylinders, headroom, height, horsepower, legroom, length, gas tank capacity, transmission type (automatic or manual), turning circle, weight, and width; the performance variables used were acceleration and fuel economy (miles per gallon). The sample period was the five-month period between April 1974 and August 1974.

The actual technique used to estimate the distribution of consumer tastes for characteristics in the hedonic market share model is complex. In short, the technique selects statistics describing a distribution of consumers' utility functions which reproduces the market shares of individual models actually observed. The selection process is performed using numerical methods.[21]

The imposition of a tariff on imported automobiles will, in the short run, change the prices of imported models. Thus, after a tariff we have a new set of available models that is known, if we assume the effect of the tariff is to raise the price of all imports by a given percent. The market shares with the initial set of models can be used to estimate the distribution of consumer taste parameters; then the estimated taste distribution can be used to predict market shares of the new set of available models.[22] Changes in the individual market shares of all imported models can then be aggregated to compute the new share of imports at the higher import prices.[23]

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[18] The hedonic market share model was originally developed at Charles River Associates by N. Scott Cardell for the purpose of estimating the effects of tariff changes on imported auto sales. The model was substantially improved and extended through subsequent work funded by Charles River Associates, the Electric Power Research Institute, and the Bureau of International Labor Affairs, U.S. Department of Labor. A complete statement of the model is presented in [5]. A full discussion of the application of this model to estimation of import share demand is presented in [6, chap. 3, sec. G and chap. 3, app. D]. A shorter discussion, based on the same materials, is included in the Appendix to this paper.

[19] For a theoretical discussion that views consumer goods as bundles of attributes, see [16]. For an example of a statistical model that estimates the probability of choosing between alternative goods as a function of their attributes, see [18].

[20] For the share estimates to be reasonable, market coverage of the set of automobile models included should be almost complete. This condition was met in the sample used, which excluded only a few specialty cars which accounted for less than 1 percent of all sales in the sample period.

[21] The algorithm used to generate the estimates of the distribution of the parameters of consumers' utility functions is described in [5].

[22] The new set of automobile models is the same as the original set, except that import prices are higher. In principle, the hedonic market share model can be used to estimate the effect on market shares of many other changes including, for example, taxes on weight, horsepower, or fuel consumption or improvement in fuel economy of a given class of models. It can also be used to predict the market share of a new automobile model, if the model's price and characteristics are known.

The advantage of the hedonic market share model is that it enables us to use considerable detailed information on the product differentiation characteristics that make imports attractive to some new car buyers. The technique provides actual estimates of the distribution across consumers of subjective tradeoffs among different characteristics and price, and thus it yields insights into the number of buyers who are just at the margin between purchasing a domestic car and purchasing an import, as well as how many are willing to pay a much higher price for an import. Further, the technique in principle will predict *which individual import models* will lose sales because of a tariff, as well as the aggregate import sales decline. Tables 4 and 5 summarize the results of the first run of the hedonic market share model.[24]

Table 4 compares the predicted shares consistent with the utility function with actual market shares of different automobile types. The model was estimated using two different price variables — the one-year-old price in August 1974 of 1974 models reported in National Market Reports, Inc., *Red Book* and the estimated new transactions price of 1974 models. The new transactions price variable was corrected by applying "typical" discount factors for different types of cars reported in the annual automobile buying issue of *Consumer Reports* (April 1974) to list prices reported in the 1974 issue of *Automotive News Almanac*.

The data reported in Table 4 show that the model fits the data well, though predicted import shares are slightly higher than actual shares. One possible explanation for the "import bias" of the model may be that automatic transmission was not included as an argu-

Table 4

Comparison of Predicted Shares to Actual Shares by Automobile Type, April–August 1974

	Actual Share	Predicted Share: One-Year-Old Price	Predicted Share: Estimated New Transactions Price
Domestic Autos			
Subcompact	0.08792	0.07900	0.07767
Compact	0.21413	0.23299	0.23701
Luxury small	0.03397	0.01825	0.01822
Intermediate	0.26943	0.24582	0.25633
Standard	0.20846	0.21383	0.20982
Luxury standard	0.05108	0.05598	0.06075
Specialty	0.00299	0.00215	0.00223
All domestics	0.86795	0.84802	0.86183
Imported Autos			
Subcompact	0.08013	0.09624	0.09080
Compact	0.05340	0.04449	0.03744
Sports car	0.01200	0.00815	0.00692
Luxury	0.00444	0.00321	0.00336
All imports	0.13197	0.15209	0.13852

Definition of Automobiles by Type

Domestic Autos
- Subcompact: Gremlin, Pinto, Vega
- Compact: Hornet, Javelin, Valiant, Dart, Maverick, Comet, Apollo, Nova, Camaro, Omega, Firebird, Ventura
- Luxury small: Mustang II
- Intermediate: Matador, Satellite, Coronet, Torino, Montego, Cougar, Century, Chevelle, Monte Carlo, Cutlass, LeMans, Grand Prix
- Standard: Ambassador, Fury, Chrysler New Yorker, Dodge, Ford, Mercury, Thunderbird, Buick, Riviera, Chevrolet, Oldsmobile, Pontiac, Toronado
- Luxury standard: Imperial, Lincoln, Mark IV, Cadillac, Eldorado
- Specialty: Corvette

Imported Autos
- Subcompact: Audi Fox, Marina, Colt, Datsun B210, Fiat 128, Fiat 124, Fiat XI/9, Honda, Mazda 808, Opel Manta, Renault, Subaru, Toyota Corolla, Toyota Corona, VW Beetle, VW 412, VW Dasher, Datsun PL 610
- Compact: Audi 100 LS, Capri, Mazda RX-4, Mazda RX-2, Mazda RX-3, Peugeot 504, Saab 99 LE, Toyota Celica, Toyota Mark II, Volvo 140 Series, Volvo 164, Datsun PL 710
- Sports car: MG, Jaguar, Triumph, Datsun 260 Z, Pantera, Porsche
- Luxury: BMW Bavaria, Mercedes-Benz

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[23] The hedonic market share model, in its present form, assumes that the market size is fixed. This assumption is clearly incorrect because buyers can keep their used car an additional year if new car prices rise (or reduce automobile ownership), but the model can yield useful forecasts of the effects of import price changes on import and domestic new car *sales* if combined with estimates derived from other sources of the total market price elasticity of new car demand.

[24] The automobile characteristics used in estimating the distribution of consumer's utility functions, in addition to price, were volume, passenger area, weight, turning circle, and miles per gallon. The expense in estimating the model precluded repeated tests of alternative specifications using different combinations of variables. The mean, median, and variance of the distribution of estimated marginal values (price per characteristic), which describe the distribution of consumer tastes for automobile characteristics, are reported in [6]. The fitted distribution function was log-normal.

Table 5
Effect of Proportionate Changes in Import Prices on Market Shares from Hedonic Market Share Model

(1)	(2) Predicted Share: Base Case	(3) Predicted Share: Import Prices Up 10 Percent (Percent Change)	(4) Predicted Share: Import Prices Down 10 Percent (Percent Change)
Domestic Autos			
Subcompact	0.07900	0.08281 (+4.8)	0.07777 (−1.6)
Compact	0.23299	0.24023 (+3.1)	0.23409 (−1.1)
Luxury small	0.01825	0.01895 (+3.8)	0.01802 (−1.3)
Intermediate	0.24582	0.25287 (+2.9)	0.24347 (−1.0)
Standard	0.21383	0.21943 (+2.6)	0.21188 (−0.9)
Luxury standard	0.05598	0.05716 (+2.1)	0.05560 (−0.7)
Specialty	0.00215	0.00221 (+2.8)	0.00214 (−0.5)
All domestics	0.84802	0.87366 (+3.0)	0.83937 (−1.0)
Imported Autos			
Subcompact	0.09624	0.08124(−15.6)	0.10083 (+4.8)
Compact	0.04449	0.03560(−20.0)	0.04725 (+6.2)
Sports car	0.00815	0.00647(−20.6)	0.00873 (+7.1)
Luxury	0.00321	0.00235(−26.8)	0.00353(+10.0)
All imports	0.15209	0.12566(−17.8)	0.16034 (+5.4)

For definition of automobiles by type, see Table 4.

ment in the utility function;[25] a much larger fraction of domestic than imported autos have automatic transmission and American buyers probably place a positive bias on that.[26]

Table 5 summarizes the effects of fixed percentage changes in the prices of all imported automobiles on market shares of different major subcategories of domestic and foreign autos. Column (3) of Table 5 provides estimates of the impact of a 10 percent increase in all import prices on market shares, and column (4) estimates the effect of a 3 percent reduction of import prices.

The results in Table 5 are consistent with a priori expectations. The percentage changes in shares of domestic car types corresponding to a given percentage change in the import price are greatest for the closest substitutes for imports — the subcompact, luxury small, and compact cars — and the percentage change in import shares is greater for compact imports than for subcompact imports. Compact imports are probably on the whole closer substitutes for typical domestic automobiles than subcompact imports. However, the percentage figures partially mask the fact that large absolute changes in the share of subcompact imports and intermediate and standard domestics occur in response to the relative price change because these automobiles account for a significant fraction of domestic and import sales, respectively. For example, the predicted absolute increase in sales of domestic intermediates in response to an increase in the import price is greater than the predicted absolute increase in sales of domestic subcompacts. This result can be explained partially by shifts from imported compacts to domestic intermediates; for buyers of imported "compacts" such as Volvo and Audi a medium-sized Buick or Oldsmobile may be perceived as a better substitute than a Pinto or a Vega. In other words, it appears that automobiles in the same *price* range are better substitutes than automobiles in the same size range. Imported compacts such as Volvo and Audi, although they are smaller than domestic compacts, are more expensive than most domestic intermediates and some full-sized cars.

The relatively high percentage changes in imported sports car and luxury car sales in Table 5 reflect very small *absolute* sales changes because these two categories account for a minor fraction of the total market.

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[25] The price variable, however, was appropriately adjusted for the presence of automatic transmission.

[26] The exclusion of automatic transmission, in particular, may explain the fact that the share of domestic subcompacts is about 10 percent higher than the predicted share in Table 4, as domestic subcompacts are closest to imports in all other characteristics. Alternatively, it is possible that many people simply prefer domestic autos to imported autos of equal characteristics because of "patriotism" or suspicion of foreign products, or that the preference for domestic autos reflects some unmeasured advantage such as better availability of service facilities.

The data in Table 5 can be aggregated to obtain an estimate of the relative price elasticity of the import-to-domestic sales ratio. Simulations were performed with the estimated utility function distribution for a number of different changes in the price of imported autos. The relative price elasticity was estimated to be −1.9381 for an import price increase of 10 percent, −1.8702 for an import price increase of 1 percent, −1.8377 for an import price reduction of 3 percent, and − 1.7739 for an import price reduction of 10 percent. The estimated relative price elasticity increases in absolute terms with increases in the import price, suggesting that import shares would decline relatively more rapidly for successive increases in tariff rates.

Table 6 compares the findings from estimating the hedonic market share model with the findings from a survey questionnaire conducted by Market Facts, Inc. [20] under contract to the U.S. Department of Labor in the past year. The Market Facts survey asked buyers of imported cars how their automobile purchase decisions would have been affected by increases of $500 to $1,000, respectively, in the price of *all* imports. Counting only buyers who would have purchased a new car, and dividing the "don't know" responses in the same proportion among categories as the definite responses, we combined two tables from the Market Facts report into percentage estimates of the effects of $500 and $1,000 import price increases on new car shares.

Table 6

Comparison of Hedonic Market Share (HMS) Estimates to Market Facts (MF) Estimates of Effect of Price Increases for Imported Automobiles

	$500 Increase		$1,000 Increase	
(1) Percent of Buyers Purchasing*	(2) MF	(3) HMS	(4) MF	(5) HMS
Same car	66		24	
Others	34		76	
Others, Domestic	26	26	59	44
Subcompact	9	4	20	7
Compact	6	7	12	13
Luxury small	4	1	9	1
Intermediate	2	7	5	12
Standard	4	5	8	9
Luxury	0	1	1	2
Specialty and other	0	0	1	0
Others, Imported	8		17	
Subcompact	5		9	
Luxury small	2		5	
Luxury	0		1	
Specialty	0		1	
Total Imported	74	74	41	56

Source: [20]

*Numbers do not always add up to 100 because of rounding errors.

Columns (2) and (4) of Table 6 give the resulting predictions from the Market Facts survey of the breakdown of new car purchases per 100 initial buyers of foreign cars who are still purchasing a new car. Columns (3) and (5) show the corresponding estimates of the switch to domestic cars and the breakdown by car type of increased domestic sales from the hedonic market share model with increases in import prices of $500 and $1,000, respectively. In the hedonic market share model as currently programmed, it is not possible to predict how many people would have bought the same car.

Table 6 shows a close correspondence between the predictions from the Market Facts survey and the predictions from the hedonic market share model. For a $500 import price increase, the predicted total shift to domestic autos is exactly the same. The hedonic market share model predicts a relatively bigger shift to domestic intermediates and a relatively smaller shift to domestic subcompacts and small luxury cars than the Market Facts survey. For a $1,000 price increase, the total shift to domestic autos predicted by Market Facts is greater than the shift predicted by the hedonic market share model, as is the relative shift to subcompact and luxury small domestic autos.[27]

In all, the first-run estimates from the hedonic market share model seem quite plausible and are broadly consistent with the results of other research. The relative price elasticity is close to the lower bound estimates from the time series analysis and the predicted effect of a moderate ($500) increase in import prices on import shares is exactly the same as the implied forecast from an actual market survey using a totally different approach.[28]

Import Share Demand Estimates: Conclusions

The preceding pages have reviewed our findings on the effect of changes in the ratio of imported auto prices to domestic auto prices on the ratio of imported to domestic new car sales.

Both the time series and cross-section equations explain a large proportion of the variance in import shares.

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[27] The hedonic market share model shows a relatively greater substitutability between autos of similar price classes, and the Market Facts predictions show a relatively greater substitutability between autos of similar size classes.

[28] Future research aimed at experimenting with different forms of model specification and validating the predictions against historical experience would be useful.

Both yield coefficients indicating strong and statistically significant effects of relative price changes on import shares; the elasticities from the cross-section equations, however, were much higher. The implied long-run elasticities from the time series equations are sensitive to changes in specification because of the instability of the coefficient of lagged import share; the short-run elasticities, however, are relatively insensitive to changes in specification. The statistical findings from the hedonic market share model, which suggest that the relative price elasticity of the import-to-domestic sales ratio is almost −2.0, are very close to the results of the lower-bound estimates of the time series equation and are also close to a set of predictions derived independently by a survey questionnaire. The lower-bound price elasticity estimates from the time series equations are probably the more plausible ones because they are from equations with a better, though still far from ideal, adjustment for the upward trend in import shares. The relative price elasticity of −18 estimated in the cross-section equation is close to some of the high long-run elasticity estimates in the time series equations. The cross-section equations probably overestimate the relative price elasticity by understating the relative cost of ownership differences between domestic and imported automobiles in different states.

Effect of Imported Auto Price Changes on Domestic Sales

The effect of a tariff-induced increase in imported automobile prices on domestic sales, assuming no change in location of production of any models, can be computed by combining the relative price elasticity estimates from the import share demand equations with an estimate of the price elasticity for new car sales in the entire automobile market. Previous research on total automobile demand in the U.S. market has been extensive (e.g. [8, 11, 13, 14, 21, 22]); most past econometric work has explained new car sales as a function of a price index series, income, a variable for credit conditions, and a lagged sales or lagged stock variable. Estimated price elasticities from these studies have centered around −1.0.

For the calculations made, the parameters of a pair of linear demand equations for domestic and imported new car sales were derived as functions of the relative price elasticity of the import-to-domestic sales ratio, using 1974 sales levels and average prices of domestic and imported automobiles to convert elasticities into slopes. The equations derived were of the form

$$F = a_0 + a_1 P_F + a_2 P_D,$$

$$D = b_0 + b_1 P_F + b_2 P_D, \qquad (3)$$

where F is import new car sales, D is domestic new car sales, P_F is import new car price, and P_D is domestic new car price. The values of the parameters of the demand equation were estimated to be

$$\begin{aligned} a_1 &= -62.64 + 412.7A_1, \\ a_2 &= -335.6 - 339.2A_1, \\ b_1 &= -335.6 - 339.2A_1, \\ b_2 &= -1797 + 105.5A_1, \end{aligned} \qquad (4)$$

where A_1 is the relative price elasticity of the import-to-domestic sales ratio. As $A_1 < 0$ and $|A_1| > 1$ for all estimated import share demand equations, $a_1 < 0, a_2 > 0$, $b_1 > 0$, and $b_2 < 0$ for the entire range of estimates of A_1.

In deriving the values of a_1, a_2, b_1 and b_2, we assumed that the total market elasticity of new car demand with respect to average new car price is − 1.0 and that $a_2 = b_1$; i.e., the cross derivatives are equal.[29]

Applying equations (4), we find that a 10 percent increase in imported automobile prices leads to a 1.344 percent increase in domestic sales when the relative price elasticity of the import sales ratio is −2. For every decline in import sales of 100 units brought about by an import price increase, we calculate that domestic new car sales will increase by slightly under forty units.[30]

The percentage increase in domestic sales is relatively small in relationship to the percentage increase in the imported automobile price. As domestic automobiles account for about 85 percent of the new car market, even a one-for-one substitution of domestic autos for reduced imports would still mean a smaller percentage increase in domestic sales than the percent decline in imported auto sales. In addition, the rise in imported car prices means that, on the average, new car prices are higher. Some potential import buyers will switch to domestic new cars, but others will substitute either imported or domestic used cars.

A higher value of the relative price elasticity in (4) would imply both a greater elasticity of domestic sales with respect to import prices and a bigger increase in domestic sales corresponding to any given decline in imported auto sales.

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[29] The derivation of the parameters reported in (4) is presented in [6, chap. 8].

[30] The actual increase in domestic new car sales in response to an exogenous increase in imported auto prices will be smaller than the increase implied by applying (4) if domestic auto prices rise in response to an increase in imported auto prices. Some econometric evidence that import competition does indeed keep domestic automobile prices lower is shown in [6, chap. 4].

3. Potential Effects of Trade Policy on Production Location

In this section, we examine evidence on the minimum cost location, among several alternatives, of producing automobiles for the U.S. market. The cost comparisons presented here explain in part recent trends in production location, and give some indication both of what to expect in the future and how locational decisions might be affected by trade barriers.

The minimum cost location of automobile production is not the only determinant of where automobiles will be produced. Domestic political pressures may delay or prevent some firms from establishing production plants outside their home countries that would be warranted by economic considerations. Further, there may be lags in adjustment to changes in exchange rates and relative labor costs, partly resulting from the fact that such changes may not be viewed as permanent.

In the absence of trade barriers, international differences in production costs and intercountry transport costs of automobiles will determine the minimum cost location of automobile production. International production cost differences depend both on (1) international production cost differences when producing at or above minimum efficient scale, and on (2) the percentage cost disadvantage from producing below minimum efficient scale. The relative cost disadvantage from below minimum scale production, in turn, depends on both the shape of the production cost curve for different types of vehicles and on the demand for automobiles in different markets.

In the first part of this section, we present comparative estimates of production costs at minimum efficient scale of motor vehicle sector products in the United States, West Germany, and Japan, using data on comparative wages, materials prices, and productivity in the three countries. We then examine the implications for the cost comparisons of scale economies in automobile production. Finally, we combine the two sets of data on sales of leading imports to simulate the potential effects of trade policies on the location of small car production for the U.S. market.

International Comparison of Production Costs

Cost comparisons presented below are developed from data on comparative wages, productivity, and materials prices of inputs used in the production of automobiles. The input cost information is aggregated using weights from a U.S. input-output table. The results can be interpreted as rough estimates of the comparative costs of producing automobile industry products when each country is producing at minimum efficient scale.[31]

Our computations for 1974 show Japanese unit costs at about 83.2 percent of U.S. unit costs, and German unit costs about 9.3 percent higher than U.S. unit costs. When transport costs are added to the computation, Japanese delivered unit costs in the United States are estimated to be 3.6 percent greater than domestic unit costs of production of the same automobiles, and German unit costs are estimated to be 15.1 percent greater than U.S. unit costs. Product differentiation enables imports to have large sales in the United States even with a unit cost disadvantage. Auto production in Europe and Japan is feasible because *most* foreign manufacturers' annual output for the U.S. market is still below minimum efficient scale.[32]

The estimates shown here give a snapshot at one point in time. International comparative advantage changes with changes in exchange rates, relative domestic price levels, relative labor costs, and relative productivities among countries. However, a big disequilibrium resulting from the pegging of other currencies to the U.S. dollar prior to 1971 has been eliminated. If future changes in relative costs of production are more gradual than in the recent past, our estimates for 1974 may be reasonably indicative of international cost differences in automobile production through the mid-1970s.

The relative input prices were aggregated into a relative cost of production index using an input-output table and assuming *value* shares of all factor and material inputs were the same in every country. The relative costs of production, with value shares constant, can be expressed as

$$\frac{Ce}{Ca} = \prod_{i=2}^{n} \left[\left(\frac{p_e^{\,i}}{p_a^{\,i}}\right)\right] \frac{f_a^{\,i}}{1-f_a^{\,a}} \quad . \tag{5}$$

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[31] An alternative approach to cost comparison would be to compare prices of equivalent products in home markets using hedonic regression techniques. Such a comparison would yield a composite of the effects of cost differences at optimal scale, differences in domestic market structure (if any), effects of tariff protection, and cost differences due to differences in degree of realization of scale economies. The method used here, which compares hypothetical costs at efficient scale production levels by comparing unit input costs, although a rough approximation, yields an answer more in line with the purpose of this study than would straight output price comparison.

Some comparisons of quality-adjusted prices of automobiles in different countries in 1969 using hedonic regression techniques are presented in [15]. For a recent study of comparative prices of trucks of different weight classes between the United States and West Germany, which also used hedonic regressions, see [4].

[32] Volkswagen was a notable exception in 1974.

In equation (5), C_e is foreign average cost of production, f_a^a is the automobile industry's value share of inputs to automobile production in the U.S. input-output table, p_a^i is the unit price in the United States of the ith input, p_e^i is the unit price in the foreign country of the ith input, and f_a^i is the input's value share in the input-output table from all sectors other than the automobile industry. Equation (5) expresses relative costs of production as a weighted product of relative input prices, with the weights being each input's share of total value, net of value of motor vehicle industry sector products used up in producing motor vehicles.[33]

In deriving (5), it was assumed that all factors and material supply curves are horizontal to the automobile industry and that production functions in all countries have the same parameters. Differences in unit costs of producing automobiles are thus assumed to be caused only by differences in factor and material prices and differences in the efficiency of labor. Labor efficiency differences enter the model through the labor input price, which is computed as the ratio of relative hourly compensation and relative labor productivity. In effect, the production function is defined in "efficiency units" of labor.

Unit costs of automobile production in Germany and Japan were compared to unit costs in the United States by applying equation (5) to data on relative productivity.[34] Both West Germany and Japan were found to have lower unit labor costs and higher materials prices than the United States. Hourly compensation for workers in both Japan and West Germany is lower in comparison to the United States than is labor productivity. Both hourly compensation and productivity are higher in West Germany than in Japan; unit labor costs are almost twice as high in West Germany as in Japan in the motor vehicle sector.

Transport costs between Japan and the United States and between West Germany and the United States were computed using freight rate data between East Coast ports, Tokyo, and Bremerhaven. Shipping costs were then expressed as a fraction of U.S. price net of shipping costs of the most popular German and Japanese imports. The estimated percent increase in supply cost to the United States from shipping was estimated to be approximately 24.5 percent for automobiles made in Japan and approximately 5.5 percent for automobiles made in West Germany (see [6, chap. 6]).

Table 7 summarizes the computation of the relative supply cost to the United States of automobile sector products manufactured in West Germany and Japan.

Table 7

Estimated Relative Supply Cost Index to United States of "Typical Imports" at Minimum Efficient Scale—1973

Country	Foreign/U.S. Production Cost	Transport Cost/ Markup (Percent)	Foreign/U.S. Supply Cost
West Germany	1.093	5.57	1.154
Japan	0.832	24.52	1.036

The Shape of Production Cost Curves

Estimates of the percentage cost penalties from subefficient production volumes for different types of automobiles were developed in consultation with Professor Merrill Ebner of Boston University, one of the authors of the Consultant Report to the Committee on Motor Vehicle Emissions (CMVE) (1974), on the costs of meeting automobile pollution standards. Data on production costs developed for that report were supplemented with information collected separately on the mix of factors used in automobile production and on the division of individual cost components into fixed and variable costs; these revised data were used to compute cost curves for automobile production.[35]

Automobiles are a highly differentiated good, offered with many different features and options, as well as in different sizes, degrees of luxury, and body styles. Major components of different automobile models, as well as the final product, can be produced on the same assembly line if the models are sufficiently similar.[36] In estimating production scale economies, we divided automobiles into four categories: mini, compact, intermediate, and standard-luxury. As a reasonable approximation to reality, we assumed autos were perfect substitutes in production within each category and assumed no joint economies of production for autos in different categories.

For compact, intermediate, and standard-luxury cars, the U.S. market size is more than adequate to enable the three major domestic firms to realize most scale economies. For small cars, the market, although growing rapidly in recent years, is still relatively small and is divided among a large number of firms, both domestic and foreign. As foreign firms can realize scale economies from supplying home markets, they can produce for the U.S. market without incurring scale diseconomies even though U.S. sales are too low to support an optimal production facility by themselves. The shape of the production cost curve influences how many U.S. manufacturers produce subcompacts, the point at which U.S. companies begin to manufacture "minis" (the only current example is GM's Chevette, introduced in 1975) and the point at which foreign manufacturers view output as sufficiently large to warrant establishment of automobile production facilities in the United States.

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[33] The derivation of equation (5) is shown in [6, chap. 6, Appendix A].

[34] Data sources and problems of "matching" data defined for different sectors in different sources are described in [6, chap. 6].

[35] A number of previous studies by economists supply estimates of minimum efficient scale output of automobiles but do not quantify the percentage cost penalty from suboptimal scale output. See [24, 2, 19]. The authors disagree on the annual rate of output required to attain all scale economies.

[36] For example, a Chevrolet Vega and a Pontiac Astre might be produced together, because the main difference between the two cars is in the nameplate and in a small amount of external trim. For purposes of assessing scale economy, it is not sensible to view the Astre as a separate car with a suboptimal level of output; on the other hand Vegas and Cadillacs cannot be produced on the same line. For less extreme cases, there are joint economies of production but not perfect jointness.

Estimates of minimum efficient scale output for different stages of production of different size autos were supplied in the CMVE report. These data were combined with data on the breakdown of costs between labor, capital, and materials in different parts of the production process, the breakdown of labor costs into fixed and variable costs (materials were treated as variable and capital as fixed), and the percentage breakdown of costs among the separate stages of the production process to estimate the percentage cost penalty for output below the given optimal scale, using a linear total cost function for output below the optimal scale with a positive intercept equal to total fixed cost.[37]

Table 8 summarizes the set of estimates of relative unit production costs for below optimal scale output.[38] The table shows that unit cost eventually rises sharply at lower levels of output. Optimal scale is higher for minis and compacts than for standards and intermediates.[39] The percentage cost penalty for large cars is insignificant as long as the annual output is at least 200,000 units; however, for minis the percentage cost penalty for 200,000 units is on the order of 15 percent.

Table 8

Manufacturing Cost at below Optimal Scale for Four Types of Automobiles

Number of Units	Production Cost as Percent of Minimum Cost			
	Mini	Compact	Intermediate	Standard
400,000	100.00	100.00	100.00	100.00
350,000	102.02	100.39	100.00	100.00
300,000	104.74	100.89	100.55	100.04
250,000	108.54	103.97	101.37	100.18
200,000	114.31	108.53	105.69	100.87
150,000	124.02	116.34	113.08	105.80
100,000	143.43	131.93	127.82	115.63
50,000	201.78	178.74	172.13	145.14

Effects of Tariffs on Production Location

In the long run, we expect firms to locate production facilities for the U.S. market where supply costs are lowest. The analysis above suggests that supply costs of small car models for the U.S. market will become lower for production in the United States than for production in either Japan or West Germany as annual output levels approach 400,000 units. Tariffs may in some cases lower the output level at which unit cost becomes lower for U.S. production; in effect, tariffs can shelter firms producing at less than efficient scale.

Table 9 compares hypothetical foreign and domestic unit production costs at varying output levels. Columns (2) and (3) give the unit costs of supply (production plus

Table 9

Estimates of Relative Supply Costs to the U.S. Market from U.S. and Foreign Production of Popular Imports at Different Annual Sales Levels in the United States

Annual U.S. Sales	Cost in Japan	Cost in West Germany	Cost in the U.S.	Minimum Cost Location	
				U.S. vs Japan	U.S. vs West Germany
Case 1: No Tariff on Imported Automobiles (Index: U.S. at 400,000 units = 1.000)					
400,000	1.036	1.154	1.000	U.S.	U.S.
350,000	1.036	1.154	1.022	U.S.	U.S.
300,000	1.036	1.154	1.047	Japan	U.S.
250,000	1.036	1.154	1.085	Japan	U.S.
200,000	1.036	1.154	1.143	Japan	U.S.
150,000	1.036	1.154	1.240	Japan	Germany
Case 2: 10 Percent Supply Price Increase for Imported Automobiles (Index: U.S. at 400,000 units = 1.000)					
400,000	1.140	1.269	1.000	U.S.	U.S.
350,000	1.140	1.269	1.022	U.S.	U.S.
300,000	1.140	1.269	1.047	U.S.	U.S.
250,000	1.140	1.269	1.085	U.S.	U.S.
200,000	1.140	1.269	1.143	Japan	U.S.
150,000	1.140	1.269	1.240	Japan	U.S.

At lower outputs, Japan and West Germany have a cost advantage over the United States.

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[37] Derivation of the cost curves and a discussion of the raw data sources are provided in [6, chap. 5].

[38] Other computations were slightly different because of different assumptions about the breakdown of the markup percentage between capital costs and economic profit.

[39] The finding that the relative cost penalty for low volumes is higher in small car production follows in great part from other estimates which show that minimum efficient scale in major production processes is higher for small cars than for big cars. For an explanation of the difference in minimum efficient scale among different types of cars, see [6].

transport) to the U.S. market for autos produced in Japan and West Germany, respectively, relative to unit costs of minimum efficient scale production in the United States. Column (4) gives the unit cost in the United States for selected outputs relative to unit cost in the United States at minimum efficient scale, using the data on cost curves in mini production reported in Table 8.

In Table 9, case 1 compares supply cost to the U.S. market in the absence of a tariff. At 1973 sales levels, Volkswagen costs would have been lower if produced in the United States, but Toyota and Datsun costs would have been higher if produced in the United States.[40] If Datsun and Toyota sales continue to grow along past trends, it might become less expensive, ignoring start-up costs, to produce most Datsuns and Toyotas in the United States by the late 1970s.

Case 2 of Table 9 presents a similar cost comparison assuming a tariff on imported cars causes a 10 percent increase in the foreign supply price. The tariff reduces the level of output for which production in the United States remains the least-cost solution. However, simulation of the marginal effect of the tariff on the production location decision is more complicated than Table 9 reveals because the increase in the supply price of foreign cars reduces the volume of sales, making the appropriate sales volume for comparing unit costs lower than the 1973 sales volume.

For Volkswagen, with 469,000 sales, production in the United States remains the least-cost solution, as it was in the example with no tariffs.

For Toyota, sales in 1973 were 273,000 cars. Applying linear interpolation to the unit cost estimate of U.S. production between 250,000 and 300,000 units, we find unit cost to be approximately 6.75 percent greater than unit cost in the United States at minimum efficient scale. As production in 1974 actually occurred in Japan, where cost was about 3.6 percent greater than U.S. cost at minimum efficient scale, the price increase for Toyota brought about by the tariff is estimated to be about 4 percent if Toyota were produced in the United States. If the demand elasticity for Toyota were equal to −2, Toyota sales would decline by 8 percent to about 251,000 units. The reduction in sales would raise unit cost still further, leading to another rise in price. The solution converges to equilibrium at 244,000 units, an output at which U.S. supply price, though 9.2 percent higher than the supply price at minimum efficient scale, is still lower than the sum of Japanese supply price and the tariff. As Japanese costs are 3.6 percent higher than U.S. costs at minimum efficient scale, the tariff, by this estimate, switches Toyota production to the United States and increases the cost of a Toyota to U.S. consumers by 5.4 percent (1.092/1.036).

Use of a higher demand elasticity in the simulation could reverse the above conclusion because, if the tariff-induced price increase leads to too great a reduction in annual sales, unit costs of domestic production would become higher than the foreign supply price.

A similar computation finds that the same tariff increase would *not* have made Datsun production costs lower in the United States than in Japan at 1973 levels of demand (see [6, chap. 6]).

The rough illustrative calculations shown above indicate that tariffs may change the minimum cost level of production location, depending on sales levels, demand elasticities, and comparative production costs at scale.

Actual location decisions depend on more complex factors, including domestic political pressures and costs of relocating existing production facilities. Also, the industrial market dynamics that determine the size distribution of firms help to determine future location decisions. The current market structure, in turn, depends in part on comparative costs in recent years, as well as on random factors such as the relative ability of manufacturers to design and to market models whose features appeal to U.S. buyers. It is difficult to develop a formal, quantitative model to predict future market shares of U.S. minicar sales among domestic and foreign manufacturers. However, it is clear that continued growth in the minicar market increases the probability that a larger fraction of minicars will be made in the United States both by enabling more firms to produce at output levels close to minimum efficient scale in the United States and by increasing the relative competitive disadvantage to foreign producers.

The data in Table 7 suggest that it may be more economical to produce automobiles for the European market (though not for Japan) in the United States. The estimated relative cost advantage for production at scale in the United States instead of West Germany exceeds the estimated transport cost as a fraction of price. The current E.E.C. import tariff of 11 percent on automobiles appears from these data to be an effective barrier blocking U.S. exports for most circumstances.[41] In addition, related research suggests that the 22 percent E.E.C. import tariff on heavy trucks may also be an effective barrier impeding the growth of a large potential export market (see [4]).

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[40] Volkswagen, Toyota, and Datsun were the three largest-selling imports in 1973, with sales of 469,000, 275,000, and 228,000 units respectively. 1973 rather than 1974 sales volumes are used here for cost comparisons because the 1974 recession and energy crisis made sales volumes for both domestic and imported cars abnormally low.

[41] However, there are cases where the E.E.C. tariff might *not* be an effective barrier. For example, suppose a European manufacturer estimated a total market size of 400,000 for its closely related minicars, 200,000 in the United States and 200,000 in Europe. The scale economy data in Table 8 suggests that it would be most economical to produce all 400,000 in the same place. As the relative cost advantage of producing in the United States for the U.S. market of 15 percent exceeds the relative cost disadvantage of producing in the

The analysis presented above, though based on rough data, gives reason to believe that imports may decline in the future because of a shift in production of types of autos previously imported to the United States from Japan and West Germany. A similar analysis could be performed to determine whether or not other locations, such as Brazil and Spain, are likely to be significant exporters to the U.S. market in the future. Higher tariffs are found in some cases to lower the market size at which a shift to production in the United States is likely, although it is very difficult to compute the exact effect of any change in the tariff.

4. Conclusions

This paper has examined the role of imports in the U.S. automobile market and the ways in which changes in the import tariff may affect import shares and domestic output. Using several alternative methods of demand analysis, we showed that market shares of imported models are sensitive to changes in imported auto prices. The best estimates imply that a 1 percent increase in average prices of imported autos would lead to about a 2 percent reduction in the ratio of imported to domestic new car sales. The international comparison of production costs suggests that automobiles are less expensive to produce in the United States than in West Germany when annual output is at or above the level required to achieve most production scale economies. Production costs are lower in Japan than in the United States, but inclusion of transport costs eliminates Japan's advantage. It was still cost-effective, as of early 1976, to produce small cars in Japan for the U.S. market because U.S. sales of individual Japanese makes were still too low to allow production at minimum efficient scale.

The findings of this paper suggest that, if economic growth and sales of passenger cars in Europe, Japan, and the United States continue to increase along recent past trends, we may observe a tendency for the amount of trade in finished automobiles to decline in future years. The reasons for European and Japanese specialization in small car production for the entire world market will diminish, as it will be possible to achieve scale economies of small car production in the United States for several firms supplying the U.S. market. Some of these firms, though, may be foreign-owned.

Further rises in domestic fuel prices caused by actions of the oil cartel or by fuel conservation policies of the U.S. government, by reducing differences among major markets in the types of autos consumed, will accelerate the growth of a domestic "minicar" industry. In that case, the extraordinarily high import share in the U.S. market in early 1975 may be viewed in retrospect as a temporary disequilibrium before U.S. manufacturers adjusted by producing a mix of autos more attuned to changes in demand, especially in terms of improved fuel economy.

On the other hand, if fuel price increases level off and U.S. demand shifts away from small cars the trend toward U.S. small car production will slow down. However, imports will also decline because a shift towards big cars means a shift away from autos currently imported towards autos in which the United States specializes and for which markets are small in other countries. In this case, also, the import share is expected to remain below the 1975 peak, though imports will remain important in the U.S. auto market.

Appendix: The Hedonic Market Share Demand Model

This appendix briefly expands upon the discussion of the hedonic market share demand model summarized in the text, providing a more formal outline of the model and supplying details of the estimation of demand for automobile characteristics from 1974 data.

As noted in the text, the estimating technique assumes that individual consumers have varying demand for automobile characteristics, including price, because of differences in income, use patterns, and personal tastes. In the absence of differences in consumer preferences, we would not expect the product differentiation in the automobile market that is in fact observed.

The utility of an individual consumer i from purchase of model j can be denoted as

$$U_j^i = U(C_j, P_j, \alpha^i), \qquad \text{(A-1)}$$

where C_j is a vector of characteristics of model j, P_j is the price of model j, and α^i is a set of parameters mapping C_j and P_j into U^i . If the utility function is linear we can write $U_j^i = \Sigma_{l=1}^N \alpha_l^i C_{jl} - P_j$, where α_l^i represents consumer i's marginal rates of substitution between the N characteristics, ($l = 1, \ldots, N$) and price. The α_l^i's are different because of differences in tastes across individual consumers. Consumer i will choose a model k if

$$U_k^i (C_k, P_k, \alpha^i) \geqslant U(C_j, P_j, \alpha^i) \qquad \text{for all } j. \qquad \text{(A-2)}$$

United States for the European market with an 11 percent tariff, it would be least costly, even including the import tariff as a cost, to produce all vehicles in the United States.

We then define a set:

$$\Omega_k = [\alpha | U(C_k, P_k, \alpha) = \max_{j} U(C_j, P_j, \alpha)] . \qquad (A-3)$$

That is, Ω_k is the set of all α such that k is the utility maximizing choice. In other words, model k will be purchased by some consumers, and Ω_k defines the set of combinations of parameters of the utility function for which that model will be bought.

If we view α as a vector of random variables, we can generate a probability distribution among models:

$$Pr(k \text{ is chosen}) = Pr(\alpha \epsilon \Omega_k). \qquad (A-4)$$

We then fit a simple functional form to describe the characteristics of the utility function (i.e., the α's).

Recall that the distribution of α's reflects the distribution of consumer tastes for automobile characteristics. Let β represent a vector of sufficient statistics of the probability distribution of the α's. (For example, if the α's have a multinomial distribution, the β vectors include the mean and variance for each α and the covariance for each pair of α's.) For any given set of models, with defined values of the C vector and P_j we then have:

$$Pr(\alpha \epsilon \Omega_k) = F_k(\beta; S_1), \ldots \qquad (A-5)$$

where S_1 represents the set of prices and characteristics of the available set of models in time period 1. Equation (A–5) states that the probability that model k will be purchased depends both on the distribution of the parameters of the consumers' utility functions for characteristics, and on the price and characteristics of all available models.

The technique then seeks to find a vector β^*, such that

$$F_j(\beta^*, S_1) = f_j \qquad j=1, \ldots, N \qquad (A-6)$$

for all j, where j is an index describing the N models, and f_j is the observed market share of the jth model. In effect, the technique selects statistics describing a distribution of consumers' utility functions that reproduces the market shares of individual models actually observed. The selection process is done by numerical methods; an algorithm was developed and programmed at CRA which solves equation (A–6) for the β^*'s.

Imposition of a tariff on imported automobiles will, in the short run, change the prices of imported models. Thus, after a tariff we have a new set of available models S_2, which is known. If consumer tastes are stable as prices are changing, i.e., if β^* remains the same when S_1 changes to S_2, it is appropriate to apply equation (A–6) to solve for a new set of f_j's. In other words, the estimated taste distribution can be applied to a new set of available models to generate a new market share distribution. Individual market shares of all imported models are then aggregated to compute the new share of imports at the higher import prices.

To estimate the taste distribution of characteristics (i.e., β^*) that fits observed market shares (i.e., equation (A–6)), five characteristics variables were used: volume, passenger area, weight, turning circle, and gallons per 100 miles (GPM). Volume is defined as the product of length, width, and height, and is a proxy measure for a combination of total seating capacity and trunk space. Passenger area is computed as the product of headroom and legroom, and represents a proxy for driver and front seat passenger comfort. Utility is positively correlated with volume, passenger area, and weight. Utility is negatively correlated with turning circle diameter (the smaller the turning circle, the more maneuverable the automobile) and with fuel consumption in gallons per 100 miles. The variable "acceleration" was used in the first-run estimate but did not have the expected positive coefficient.[42]

Table A–1 summarizes statistical information on the estimated distributions of the marginal rates of substitution between characteristics and price in equation (A–6). The form of the estimated distribution function is log-normal; the statistics reported in Table A–1 were computed by taking exponents of the parameters of the normal distributions of the logs of the characteristics. As the distributions are log-normal, the mean and median of the distributions are not the same.

The numbers reported in column (2) of Table A–1, the median of the distributions, give the marginal value of an additional unit of the characteristic in dollars, where the units of the characteristics are as defined at the bottom of Table A–1. For example, the coefficient attached to *VOL* 2 indicates that the median consumer is willing to pay $2.31 for an extra 10,000 cubic inches of volume. The coefficient attached to weight indicates that the median consumer is willing to pay an additional $2.78 for an additional pound.

The coefficient on gallons per 100 miles is about twice as high as it would be if it reflected the probable first-year savings from running a more fuel-efficient automobile, but can certainly be viewed to be consistent

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[42] A possible reason that the acceleration variable does not have the expected positive coefficient is that acceleration is negatively correlated, all other things equal, with automatic transmission. Automatic transmission is probably a characteristic positively desired by many buyers, but is not included in the estimated utility function (though prices are adjusted for inclusion or absence of automatic transmission). Thus, inclusion of automatic transmission as a variable in future research may both improve the sign of the acceleration coefficient, and make the predictions slightly better.

Table A–1
Distribution of Estimated Marginal Values of Automobile Characteristics (Dollars per Unit)

(1) Characteristic	(2) Median	(3) Mean	(4) Variance in Consumer Tastes	95 Percent Consumer Taste Range* (5) Absolute Lower Bound†	 (6) Absolute Upper Bound‡
VOL 2	2.3053	7.1149	431.57	0.12156	43.717
AREAG	5.1795	5.8383	9.2219	1.9850	13.515
WEIGHT	2.7782	3.1316	2.6532	1.0648	7.2492
TURN	−7.4435	−303.29	−152,630,000	−0.03581	−1,547.4
GPM	−565.42	−637.33	−109,990	−216.70	−1,475.30

Variable Definitions

VOL 2 = (0.0001) × (length) × (width) × (height) (in cubic inches)
AREAG = (headroom) × (legroom) (in square inches)
WEIGHT = weight (in pounds)
TURN = turning circle diameter (in feet)
GPM = gallons per 100 miles

*Range of values of marginal rates of substitution including 95 percent of consumers.

†2.5th percentile of consumer taste distribution.

‡97.5th percentile of consumer taste distribution.

with rational behavior. A simple example serves to illustrate this point. Suppose the typical domestic car mileage is 15 miles per gallon, and the typical import mileage is 25 miles per gallon. Then, mileage falls by about 2.7 gallons per 100 miles with a switch from the domestic to the imported automobile. If a typical new car is driven 12,000 miles and the price of gasoline is $.60 per gallon, then the annual savings for the more fuel-efficient auto is about $194 (the product of miles driven, gasoline price per gallon, and the improvement in gallons per mile). The coefficient of GPM in Table A–1 indicates that the median consumer is willing to pay $565.42 for an additional gallon per 100 miles, or $1,527 for an additional 0.027 gallon per mile. If the depreciation rate on a new car is 20 percent in the first year and the interest rate is 5 percent, then the annual fixed cost of spending $1,527 extra for a new car is (0.25) × ($1,527), or approximately $382 in the first year. In that case, the annual amount a consumer is willing to pay for owning a new car with improved mileage is about double the annual savings in gasoline cost.

Two factors could account for this difference between the estimated utility of better mileage and the estimate of gasoline cost savings. First, the combined interest and depreciation as a fraction of new car price is much lower in subsequent years than in the initial year of ownership; if the buyer is not planning to sell the car in the first year and has a longer time horizon, the annual cost of a price increase of $1,527 may be considerably lower than $382. Second, in 1974 buyers may have been expecting gasoline prices to rise or may have feared future shortages and/or rationing because of the experience in the previous winter. For this reason, additional fuel economy in an automobile may have been valued at more than its current dollar savings in lower fuel consumption. For these reasons, the coefficient of gallons per mile reported in Table A–1 certainly seems to be well within the range of reasonable values.

The upper and lower bounds of the 95 percent range indicate the degree of dispersion in tastes for each characteristic among consumers. The most widely dispersed values are for the characteristic "turning circle"; this result appears to make some sense because some buyers place a very high value on a car that handles well and can get into small parking places, while other buyers have practically no use for that characteristic. The dispersion of the coefficient attached to gallons per mile reflects differences among buyers in annual miles driven, subjective discount rates relating current to future cost savings, expected length of ownership of an automobile, and expectations about future trends in gasoline prices and availability.

The estimated distribution of consumer tastes for automobile characteristics shown in Table A–1 is used to generate the predicted shares for alternative sets of available domestic and imported models (defined by characteristics and price) reported in Tables 4 and 5 of the text.

Literature Cited

1. Austin, Thomas C., and Karl H. Hellman. *Passenger Car Fuel Economy – Trends and Influencing Factors.* Paper presented to National Combined Farm, Construction and Industrial Machinery and Fuels and Lubricants Meetings, Milwaukee, Wisconsin, September 10–13, 1973.
2. Bain, Joe S. *Barriers to New Competition: Their Character and Consequences in Manufacturing Industries.* Cambridge, Mass.: Harvard University Press, 1956.
3. Chamberlain, Charlotte. "A Preliminary Model of Automobile Choice by Class of Car." Transportation Systems Center Discussion Paper, January 31, 1974.
4. Charles River Associates. *Analysis of the Effects of Trade Policy Changes on the U.S. Truck Industry.* Final report submitted to U.S. Motor Vehicle Manufacturers Association, April 1976.
5. ______. "The Development of a Methodology for Predicting the Demand for New Goods with Illustrative Applications to Residential Heat Pumps." Draft report submitted to Electric Power Research Institute, July 1976.
6. _____. *Impact of Trade Policies on the U.S. Automobile Market.* Final report submitted to U.S. Department of Labor, Bureau of International Labor Affairs, October 1976.
7. Chase Econometric Associates Inc. *The Effect of Tax and Regulatory Alternatives on Car Sales and Gasoline Consumption.* Submitted to Council on Environmental Quality, May 1974.
8. Chow, Gregory C. "Statistical Demand Functions for Automobiles and Their Use in Forecasting." In *The Demand for Durable Goods*, edited by Arnold C. Harberger. Chicago, Ill.: University of Chicago Press, 1960.
9. Consultant Report to the Committee on Motor Vehicle Emissions, Commission on Sociotechnical Systems. *Manufacturability and Costs of Proposed Low-Emissions Automotive Engine Systems.* Washington, D.C.: National Research Council, September 1974.
10. Cowling, K., and J. Cubbin. "Price, Quality and Advertising Competition: An Econometric Investigation of the United Kingdom Car Market." *Economica*, 38 (November 1971), 378–94.
11. Cragg, John C., and Russell S. Uhler. "The Demand for Automobiles." *Canadian Journal of Economics*, 3 (August 1970), 386–406.
12. Difiglio, Carmen, Damian Kulash, and Anthony Morton. *Marketing and Mobility Panel Report.* Prepared for the Interagency Task Force for Motor Vehicle Goals Beyond 1980, March 1, 1976.
13. Dyckman, Thomas R. "An Aggregate Demand Model for Automobiles." *Journal of Business*, 38 (July 1965), 252–66.
14. Farrell, M. J. "The Demand for Motor Cars in the United States." *Journal of the Royal Statistical Society in the United States*, 117 (Part 2, 1954), 171–93.
15. Kravis, Irving, Zolten Kenessey, Alan Heston, and Robert Summers. *A System of International Comparisons of Gross Product and Purchasing Power.* United Nations International Comparison Project: Phase One. Washington, D.C.: International Bank for Reconstruction and Development, 1975.
16. Lancaster, K. J. "A New Approach to Consumer Theory." *Journal of Political Economy*, 74 (April 1966), 132–57.
17. Linden, Fabian. "The Market for Foreign Cars." *The Conference Board Record*, 10 (June 1973), 62–64.
18. McFadden, Daniel. "Conditional Logit Analysis of Qualitative Choice Behavior." In *Frontiers in Econometrics*, edited by Paul Zarembka, pp. 105–39. New York: Academic Press, 1974.
19. McGee, John S. "Economies of Size in Automotive Body Manufacture." *Journal of Law and Economics*, 16 (October 1973), 239–74.
20. Market Facts Inc. *A Foreign Automobile Impact Study.* Report submitted to U.S. Department of Labor, Bureau of International Labor Affairs, March 1976.
21. Nerlove, Marc. "A Note on Long-Run Automobile Demand." *Journal of Marketing*, 22 (July 1957), 57–64.
22. Suits, Daniel. "Exploring Alternative Formulations of Automobile Demand." *Review of Economics and Statistics*, 43 (February 1961), 66–69.
23. Triplett, Jack E., and Keith Cowling. "A Quality-Adjusted Model for Determining Market Shares in Oligopoly." U.S. Department of Labor, Bureau of Labor Statistics, Working Paper 4, December 1971.
24. White, Lawrence J. *The U.S. Automobile Industry Since 1945.* Cambridge, Mass.: Harvard University Press, 1971.

Comment

Helen M. Kramer

My comments will deal with the policy implications of the Charles River Associates' (CRA) study of the automobile industry [1].

Since my credentials include a doctorate in economics from a reputable university, I hope this audience will not interpret my remarks about the biases of the economics profession as merely an expression of distemper.

Robert Lekachman titled his most recent book: *Economists at Bay—Why the Experts Will Never Solve Your Problems*. To quote: "The touble with economics is the profession's addiction to techniques diminishingly relevant to the institutions and interests which determine prices, employment, growth, and prosperity and depression. The world will continue to astonish economists so long as they concentrate upon the small incremental changes in purely economic magnitudes to which their training has habituated them" [3, p. 7].

My criticism will focus on several aspects of CRA's estimates of the social welfare impact of a tariff increase on automobiles. First, the social cost of unemployment is seriously understated. CRA relies on the results of a study by the Center for Naval Analyses of auto workers' earnings losses from unemployment. The acceptance of such a measure is an illustration of the kind of tunnel vision characteristic of the economics profession.

The report states, "On balance, we believe that the earnings loss measure overstates the cost of unemployment, especially the private cost because of the large unemployment compensation payments received by displaced auto workers."

However, the system of Supplemental Unemployment Benefits (SUB) won by the United Auto Workers in contracts with the Big Four companies was designed to cushion workers against the short-term layoffs characteristic of the industry's operation—for example, the layoffs occurring as a result of shift cancellations or plant shutdowns to reduce inventories of certain models, or as a result of shutdowns for the purpose of retooling. During the massive layoffs in the period following the Organization of Petroleum Exporting Countries' embargo, which for many workers lasted over a year, laid-off auto workers exhausted their entitlement to benefits, and the SUB funds at General Motors and Chrysler were completely exhausted. Even these workers were fortunate compared with those working for independent suppliers, who do not have SUB funds.

Furthermore, it is important to note that extended unemployment results in more than loss of earnings:

- once SUB entitlements are exhausted, the worker loses company paid medical insurance coverage for himself and his family;
- workers unable to keep up with mortgage and installment payments would lose equity accumulated in homes and consumer durable goods purchased on credit;
- workers with seniority rights who are not recalled lose service credits accumulated toward pension benefits as well as seniority in their place of new employment, where it is available, which subjects them to greater vulnerability to future layoffs and permanent reduction of earnings and benefits in alternative employment.

Certain costs of extended unemployment are not measurable by conventional means. It is noteworthy that the authors completely ignored recent research findings on the impact of unemployment on physical and mental illness, mortality rates, and deterioration of family relations manifested in higher divorce rates and child abuse. In contrast, they assert: "earnings loss overstates the social cost of unemployment by not valuing the gain to employees in increased leisure time." It is obvious the authors have never stood in an unemployment line.

The authors' narrow focus also left out of view the interrelatedness of the auto industry and other industries. During 1964–74, average direct employment in motor vehicle manufacturing (Standard Industrial Classification 371) was 860,000, while related indirect employment was 497,000—a total of about 2.4 million jobs. The Bureau of Labor Statistics estimates that unemployment of 100,000 auto workers leads to unemployment of about 175,000 workers in other industries, but CRA did not take this into account.

Second, the study does not even begin to do justice to the problems of stagnating or declining employment in the auto industry and the implications for the national unemployment problem. In fact, the latter aspect is dismissed in a footnote. If the experience of the 1960s taught economists anything, it should have driven home the lesson that reliance on macroeconomic fiscal and monetary policies to regulate aggregate demand is not an effective instrument for ensuring adequate employment opportunities.

I shall outline the reasons for expecting future employment in the auto industry to stagnate or at best grow slowly.

- Productivity of labor is expected to continue to increase in the auto industry. During 1957–72 the increase averaged 3.8 percent a year.
- Legislation mandating gradual increases in sales-weighted average fuel economy of U.S. autos will require a continuing shift in the industry's product mix toward smaller cars, which require less labor input. In 1974 it required 24 worker-hours to assemble a standard-size car and 16 to assemble a subcompact car.
- The U.S. auto companies are producing an increasing number of cars and automotive components abroad for import into the United States.
- Substantial tariff and nontariff barriers exist to the export of U.S.-made motor vehicles to the rest of the world. Included among these is the fact, totally ignored by the report, that the Big Three companies have plants in Europe and have no motivation to compete with their European facilities by exporting from the United States.
- The number of autos per capita is approaching a maximum. Currently there is one car for every 2¼ people. Net new car demand has come mainly from the growth in multicar families.
- The percent of real disposable income spent on autos has been declining.

The Carter administration is coming into office at a time of high and rising unemployment. During the campaign, President Carter promised to take vigorous action to reduce unemployment. There are two ways of looking at the role of public policy toward the auto industry in relation to the unemployment problem. One is to define the problem narrowly in terms of unemployment of auto workers in local labor markets such as Detroit, where alternative jobs are unavailable. This is the approach taken by the present study. The second way is to ask whether employment opportunities for other kinds of workers can also be expanded by policies affecting the auto industry. This approach is rejected by the authors in a footnote: (p. 349) "While there is undoubtedly a net social gain in providing automobile industry employment for *any* otherwise unemployed worker, there is no logical reason why it would be easier to employ nonauto industry workers in the auto industry than anywhere else; thus, there is no argument for an auto import tariff as a weapon against general unemployment."

Part of the problem lies in the narrow way the authors have phrased the question. They have not explored whether tariff policy can be used in a way that would increase domestic employment and social welfare. Instead, they have adopted the absurd assumptions of orthodox welfare economics about perfectly competitive markets, consumer rationality, and a fixed pattern of income distribution whose justification cannot be questioned within the framework of the theory. On this basis they measured the alleged social losses and gains from raising the tariff on autos and made the customary pious statements about the allocation of resources. The fact that welfare economics is based on the static assumptions of neoclassical economics, in which relatively minor adjustments take place in an economy of full employment of all resources and pure competition in product and factor markets, does not cause the authors any qualms in making policy prescriptions for the real, very imperfect world. The authors state: (p. 323) "While the simple consumer surplus analysis used here has some theoretical and empirical shortcomings and qualifications, it still provides a reasonable approximation of the net social gains, or losses, from changes in trade restrictions." The fact is that most quantitatively oriented economists will adopt whatever absurd assumptions are necessary to enable them to write equations that can be processed on a computer.

Not surprisingly, the authors conclude that the social losses of a tariff increase would outweigh the gains, measured by the reduction in auto workers' unemployment. I have already discussed the serious underestimation of the cost of unemployment, which results in the underestimation of the gains from its reduction. For those who might actually read the report, I should also point to other reasons why the calculations should not be taken seriously. For one thing, although the text repeatedly refers to a 10 percent tariff, in fact the calculations were based on an increase in retail foreign car prices of 10 percent, which, given the existing methods of U.S. Customs valuation, would imply a tariff considerably higher than 10 percent.

Another area where reality interferes with the statistical requirements of the analysis and is therefore dismissed is in the specification of pricing behavior. The price formation equations for domestic autos assume that prices of imported autos are independently determined, exogenous variables. The evidence in the auto dumping case, however, indicated that foreign manufacturers establish prices according to conditions in the export market [2]. Admissions of this practice are occasionally quoted in the business press. The interdependence of the supposedly independent variables raises serious doubts about the validity of the results.

I would like to suggest an alternative way of viewing the tariff as a policy instrument. For reasons about which I shall refrain from speculating, the authors of this study acknowledged in passing that an increase in the tariff could speed up the opening of assembly plants in the United States by foreign producers, but then dismissed the idea. Let us explore this idea further.

CRA's estimates of comparative production costs as of 1973 indicate that when shipping costs are taken into account, production of Toyotas and Datsuns would be slightly cheaper in the United States than in Japan. Since that date inflation has been much greater in Japan than in the United States and the yen has risen in value compared with the dollar. Both factors tend to raise the cost of producing autos in Japan for the American market relative to costs in the United States at minimum efficient scale, which CRA estimates as 400,000 cars a year.

Automotive trade with Japan is notoriously lacking in reciprocity. Imports from all sources account for less than 2 percent of the Japanese market, largely as a result of Japanese nontariff barriers. In 1975, the United States imported 695,573 autos and 138,875 compact pickup trucks from Japan, valued at almost $2.1 billion, while U.S. exports to Japan were only 14,842 autos and no trucks whatsoever.

There are a number of reasons for expecting that the U.S. market will be able to support a Japanese-owned assembly plant at efficient scale. First, any OPEC-imposed increase in petroleum prices will raise the cost of shipping autos from Japan. This will change the breakeven point between production in Japan and production in the United States in favor of the latter. At the same time, any further increase in domestic gasoline prices would widen the market for fuel-efficient cars.

Second, adults twenty to thirty years old, who normally account for a high proportion of auto purchases, appear to prefer smaller cars. Further increases in gasoline prices would intensify this preference. Recovery from the recession would increase demand among this population group, which has experienced above-average unemployment rates and losses in real income.

Third, resumption of the trend of rising real disposable income would increase the number of multicar households, with additions to the car stock most likely to be subcompacts for short-distance city driving.

Between the date of a decision to open an assembly plant and actual production, there is a lapse of at least two years, as the recent experiences of Volvo and Volkswagen demonstrate. The Japanese auto companies have given contradictory indications of their intentions. On several occasions they stated that they will postpone a decision until sales in the United States have reached 400,000 units and on other occasions they have denied that they are seriously considering production in the United States. An announcement by the U.S. government that, in view of the high rates of domestic unemployment, the tariff on autos will be increased on a date three years hence would have a salutary effect on the production location decision.

There are special reasons for fostering the growth of auto industry employment through import substitution as part of an economic recovery program. Numerous analyses of the characteristics of unemployed workers and new entrants to the labor force have stressed that the most urgent need is for greatly expanded job opportunities in unskilled occupations. Auto assembly work is unskilled labor and totally inexperienced persons can be trained on the job to perform any task. At the same time, wages and benefits are substantially above the average for manufacturing industries. Thus, expanded job opportunities in this industry are a potential vehicle for the absorption of chronically unemployed minorities into the labor force and an aid to correction of the imbalance of income distribution between whites and nonwhites.

I challenge the authors of this report and its sponsor, the Bureau of International Labor Affairs, U.S. Department of Labor, to offer an alternative program of job creation that would provide equal social benefits at lower social cost.

Literature Cited

1. Charles River Associates. "Impact of Trade Policies on the U.S. Automobile Market." Prepared for the Bureau of International Labor Affairs, U.S. Department of Labor, October 1976.
2. Kahn, Helen. "Treasury to Drop Import Dumping Probe." *Automotive News* (May 10, 1976) 1, 31–32.
3. Lekachman, Robert. *Economists at Bay: Why the Experts Will Never Solve Your Problems*. New York: McGraw-Hill, 1976.
4. U.S. Bureau of Labor Statistics. *1975 Manpower Report of the President* and *The Structure of the U.S. Economy in 1980 and 1985*. BLS Bulletin 1831 (1975).

Comment

Jack E. Triplett*

This comment will be concerned solely with methods for estimating the demand for imports. Most studies of import demand, and import substitution for domestically produced goods, employ what I characterize below as the "conventional method." Eric Toder [10] follows this tradition, but also introduces a new method, the "CRA hedonic market share model" (hereafter, the "HMS model").

In this note, I wish to make but two points: (1) The general *approach* to demand analysis embodied in the HMS model has considerable potential for studying import demand, and for all similar problems where it is necessary to model the demand for particular varieties of goods. (2) The *particular* model developed by Toder and his associates has serious deficiencies, for in developing a new empirical approach to demand analysis, they have neglected what the theory of demand tells us about the subject.

The General Approach

The HMS model derives the demand for a particular variety of car from underlying consumer preferences for automotive characteristics (carrying capacities, fuel economy, performance, and so forth). The value of the characteristics approach to import demand analysis can best be demonstrated by considering the information one gets from conventional methods.

When conventional methods of demand analysis are applied to estimating the demand for imported cars, imports and domestically produced automobiles are treated as if they were different goods. The only information necessary is prices and quantities sold for domestic and imported cars. Standard techniques will produce various elasticities ("own" price, cross-price, substitution) that will measure how demands for the two types of autos will vary as their prices change relative to each other.

Such elasticities would appear to be exactly what we require. The difficulty is that the elasticity estimates will vary with the composition of imported and domestically produced cars. Thus, if imports are Volkswagens and other small cars, and domestics are full-size Fords and Chevrolets, the conventional technique will produce a measure of substitutability between imports and domestics that will probably be quite different from what we would get if small cars such as Vegas and Pintos were added to the list of domestics. Using conventional techniques, if a new type of domestic or imported car appears (or if one of them changes specifications in order to fill a "gap" in the market) we simply get new elasticities—after the fact. There is no way to predict how shares will change in response to such product-line shifts, or to tell how they may affect the elasticities. Clearly, this is a serious liability, for the history of imported car sales in the United States suggests that these factors have frequently been associated with changes in market shares.

A characteristics demand model, the HMS model being one example, has the potential to do exactly what conventional techniques cannot do—predict how shares will change when a new car, or a change in specifications, appears. Though economists interested in estimating import elasticities have so far paid little attention to the characteristics approach, Toder's paper is evidence suggesting that such methods will eventually prove practicable, given development and the incentive to collect or generate the kind of data that the characteristics approach to demand analysis requires.

Problems with the HMS Model

Though I applaud the approach taken in the HMS model, I have reservations about its execution.

The HMS model can be viewed as an empirical implementation of ideas from a large body of economic literature, in which the analysis of collections of characteristics provides the common feature. One may include under this heading such diverse examples as Lancaster's well-known work on the theory of consumer demand for characteristics [6], Thomas King's analysis of the demand for housing characteristics [5], an extensive (and rather confused) literature on air quality and property values, the literature on "human capital" (on one interpretation—see [13]), and the analysis of wages and working conditions using "hedonic wage equations," along the lines of Antos and Rosen [1]. Central to all of these various areas of research is the "hedonic function," a construction that has a rather long history, and which first emerged in the economic literature as a proposal for improving methods for handling quality change in price indexes.

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*The views expressed are those of the author and do not reflect the policies of the Bureau of Labor Statistics or the views of other BLS staff members.

I have pointed out elsewhere [12] that the role played by the hedonic function (which is a relation between the market prices of the goods themselves and the quantities of characteristics embodied in them) with respect to the demand for characteristics is directly analogous to that of the budget constraint in the conventional theory of consumer demand. One chooses a particular car, in this way of looking at things, by finding the car that provides the optimal set of characteristics for each consumer's particular preference function, given that there is a set of prices for the various characteristics to which the consumer responds. For any consumption problem there must be a budget constraint, in recognition of the fact that a consumer's choices are constrained by his resources. In the analysis of characteristics demand, the constraint takes the form of an opportunity locus that shows alternative quantities of characteristics that can be purchased for the same total expenditure. The opportunity locus is derived from prices for goods (via the hedonic function), although it is *defined* on characteristics. It embodies "implicit" prices for characteristics, which prices are estimated from the hedonic function (for more details, see [12]).

Though Toder estimates some hedonic functions in one part of his study, the HMS model makes no direct use of hedonic prices for characteristics. In fact, the HMS model lacks any explicit budget constraint or reference to characteristics prices, which leads to some confusing problems in interpretation, and some empirical results that suggest that something is wrong. Consider, as an illustration of the latter point, a comparison of prices and valuations from different parts of the study.

The variables chosen to represent automobile characteristics and the HMS model results are arrayed in Toder's appendix Table A–1. Toder interprets the numbers reported in this table as the "marginal value of an additional unit of the characteristic in dollars." That is, the model is interpreted as indicating what consumers *would be willing to pay* to get an additional unit of a particular characteristic on the cars they buy. For weight,[1] to take one example, that valuation is $2.78 per pound.

A hedonic equation on automotive characteristics, on the other hand, provides an estimate of the prices actually charged in the market for additional units of characteristics. Toder's own hedonic equations[2] indicate the price of weight varies for different size classes of cars. Because of the functional form used in the estimation, the characteristic price is expressed as a percentage: For subcompacts, each additional pound of weight costs 0.026 percent. For compact cars, a 2.0 percent increase is charged for every extra pound of weight. Assuming that the average subcompact car costs $3,000 and the average compact car costs $4,000, the hedonic prices suggest that an incremental pound of weight in a subcompact sells for around 78 cents; in a compact, however, the price is much higher, in the vicinity of 80 *dollars* per pound. But in the market shares part of the study we were told that people are willing to *pay* $2.78 per pound. If this were really true, then we would have to conclude that consumers want more weight in subcompact cars (because they value weight at $2.78 per pound, whereas it costs only 78 cents per pound for these cars); at the same time, however, they want smaller, lighter compact cars (because their $2.78 valuation of a pound of weight on these cars is far under its rather high $80 cost). In other words, people want to buy larger small cars and smaller big cars! Such results seem inconsistent, to put it mildly.

The paper does, of course, reference all kinds of qualifications: the HMS model is only very preliminary, it is by no means certain that the variables are entirely the appropriate ones, somewhat different variables appear in the hedonic function than in the market shares model, and so forth. I would add another to the list: theory suggests that in the hedonic world, consumers will typically be at corner solutions, so exact equality between characteristics price ratios and marginal rates of substitution will not in general be attained. Although due allowance should be made for all these points, the discrepancy between hedonic prices and HMS model evaluations is too large to be explained by any aspect of the automobile market.

What seems to be wrong is that the HMS modelers have tried to model consumer choice toward automotive characteristics without incorporating the prices of characteristics into the model in any explicit way. Instead, they have entered the *price of the car* in what they refer to as the utility function, and performed an unconstrained maximization. There can be no theoretical justification for writing price as an argument of the utility function. The best that can be said for this way of writing a demand model is to argue that it can be given a rationalization as some sort of reduced-form estimation. Because such a rationalization provides insight into what is really going on in the HMS model, and suggests follow-up research strategies, it is worth developing briefly in the remaining space.

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[1] Weight has a long history of use in studies as a characteristic of automobiles, even though it is quite clear that weight in and of itself makes no contribution to the usefulness of an automobile. It is not entirely unreasonable, however, because it stands as a proxy for a whole host of things which are desirable. Unfortunately, the proxy relationship frequently introduces problems that can be serious, especially when it comes to interpreting the results. See [11].

[2] The hedonic price functions were used to construct the price indexes for the "time series" demand estimates (that is, Toder's equation 2.1 and the consequent Tables 2.1 and 2.2), and were not reproduced in the paper prepared for this volume. The numbers cited in the present note were taken from [3, Table 3.5, p.8].

We first assume what has come to be known as a "two-stage budgeting procedure" [2] or "utility tree" [8]. This permits forming a utility function on automotive characteristics and neglecting—after the overall allocation to automotive expenditures has been established—prices of other consumption goods in analyzing choice of a particular model of car. Next, we specify a functional form for the resulting "branch" utility function on automotive characteristics (from which one derives estimating equations for a set of demand functions on automotive characteristics). Such a procedure is not so very unusual in demand analysis. Christensen and Manser [4], for example, use similar assumptions and methods to estimate demand equations for a "meat branch," with beef, pork, and so forth, as the goods. To perform an equivalent study on automobile characteristics, the category "automobiles" replaces "meat," with (e.g.) the characteristic "fuel economy" treated equivalently to Christensen and Manser's "beef" or "pork." Toder uses a linear utility function, Christensen and Manser the translog utility function; other forms are available.

A budget constraint is needed for the maximization process, and this can in principle be derived from the hedonic function. Again, there is a precedent in the work of King, who employed a Rotterdam demand model, the "branch" utility function idea, and hedonic prices for characteristics.[3] Finally, one specifies taste distribution parameters along the lines suggested in Toder's appendix (or in [6, chap. 7] where a very similar procedure for predicting market shares is proposed, though Lancaster suggested a Cobb-Douglas utility function). The remainder of the investigation could follow the outline in Toder's appendix (equations A–4 through A–6).

The HMS model simply short-circuits the first few steps of the above process, by inserting the price of the car in an equation containing the quantities of automobile characteristics (equation A–1). In the hedonic world, however, the price of the *car* is interpreted as total expenditure on characteristics—that is, for the functional form employed by Toder,

$$\text{Car price} = e^{(\Sigma p_i q_i)},$$

where p_i and q_i are price and quantity of the ith characteristic. The introduction of this quantity into what is labeled a "utility function" (equation A–1) thus serves to proxy for the effect of characteristics prices on choice of characteristics *and* for the "first stage" budgeting level, where expenditures on automobiles and nonautomotive goods are determined. Equation A–1 is, therefore, not a utility function, properly speaking, but some sort of amalgam of a utility function and a function that specifies consumption opportunities. Writing the problem in this way does not evade the difficulty of dealing in characteristics prices (which, because they must be estimated from a hedonic function, are in some sense data not as "hard" as more conventional price data), or setting up a budget constraint from hedonic prices. Rather, the hedonic function is tangled up in the resulting estimates in a way that is very hard to disentangle and nearly impossible to evaluate.

Thus, the traditional consumer demand literature involving sets or systems of demand equations derived from explicitly modeled utility functions provides a framework that meshes theory and econometric specification, and could be adapted to the task of estimating demand for automobile characteristics, if one recognizes the proper role and interpretation of hedonic prices. The traditional approach simply treats imports and domestically produced cars as different goods; it then relies on consumer theory to construct demand curves for these two goods. In the process, it ignores two fundamental aspects of the problem—the characteristics of the cars that are being analyzed, and the nature of a discrete choice problem (which arises in the purchase of any large durable good because people usually purchase only one at a time rather than a little of this and a little of that). The HMS model explicitly incorporates the discrete choice problem and the analysis of characteristics, and this is its strength. Its weakness, however, is that it ignores the traditional theory of consumer demand—that is, a world in which consumers maximize utility in a setting in which prices are parameters forming constraints on their behavior.

I think Toder (and Scott Cardell, who is credited with development of the HMS model) deserve credit for jumping off into uncharted and treacherous terrain. These comments are intended to point out some of the quicksand encountered in the first step.

One final remark is directed toward anyone who wishes to extend the approach. So much data are available on cars that it should not be difficult to choose variables that correspond with what consumers really want, and to avoid the use of rough proxies such as weight, which causes too many problems in interpreting and using the results. Ohta-Griliches [7], for example, experimented with *Consumer Reports* data, and there is now EPA data for all cars on such characteristics as fuel economy and standardized acceleration times. The hedonic tradition of using whatever convenient proxy variables that seem to work in the equations should be abandoned without regrets.[4]

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[3] The reader is warned that there are many difficulties involved in this step, and King's solutions are not the only ones possible.

Literature Cited

1. Antos, Joseph R., and Sherwin Rosen. "Discrimination in the Market for Public School Teachers." *Journal of Econometrics*, 3 (1975), 123–50.
2. Blackorby, D., D. Primont, and R. R. Russell. "Budgeting Decentralization, and Aggregation." *Annals of Economic and Social Measurement*, 4 (Winter 1975), 23–44.
3. Charles River Associates. "Impact of Trade Policies on the U.S. Automobile Market." Report prepared for the Bureau of International Labor Affairs, U.S. Department of Labor, October 1976.
4. Christensen, Laurits R., and Marilyn E. Manser. "Cost of Living Indexes and Price Indexes for U.S. Meat and Produce, 1947–1971." In *Household Production and Consumption*, edited by Nestor E. Terleckyj. Studies in Income and Wealth, vol. 40. New York: National Bureau of Economic Research, 1976.
5. King, Thomas A. "The Demand for Housing: Integrating the Roles of Journey-to-Work, Neighborhood Quality, and Prices." In *Household Production and Consumption*, edited by Nestor E. Terleckyj. Studies in Income and Wealth, vol. 40. New York: National Bureau of Economic Research, 1976.
6. Lancaster, Kelvin. *Consumer Demand: A New Approach*. New York and London: Columbia University Press, 1971.
7. Ohta, Makoto, and Zvi Griliches. "Automobile Prices Revisited: Extensions of the Hedonic Hypothesis." In *Household Production and Consumption*, edited by Nestor E. Terleckyj. Studies in Income and Wealth, vol. 40. New York: National Bureau of Economic Research, 1976.
8. Strotz, Robert H. "The Empirical Implications of a Utility Tree." *Econometrica*, 25 (April 1957), 269–80.
9. Theil, Henri. *Theory and Measurement of Consumer Demand*, Vol. 1. Studies in Mathematical and Managerial Economics. University of Chicago, North-Holland Publishing Company, 1975.
10. Toder, Eric. "Effects of Trade Barriers on the U.S. Automobile Market." Presented at a conference sponsored by the Bureau of International Labor Affairs, U.S. Department of Labor, December, 1976.
11. Triplett, Jack E. "Automobiles and Hedonic Quality Measurement." *Journal of Political Economy*, 77 (May/June 1969), 408–17.
12. ———. "Consumer Demand and Characteristics of Consumption Goods." In *Household Production and Consumption*, edited by Nestor E. Terleckyj. Studies in Income and Wealth, vol. 40. New York: National Bureau of Economic Research, 1976.
13. ———. "Measuring Prices—and Wages." *American Economic Review*, 67 (February 1977), 135–40.

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[4] In an ideal research setting, one would ask that the investigation be conducted on characteristics of automotive services (rather than just cars), that the demand for services be derived from the underlying demands for service characteristics, and all of this be used to predict the demand for new cars. This is clearly beyond the realm of the possible with currently-developed techniques, and for some cases will result in the same model.

Reply

Eric Toder with N. Scott Cardell

Dr. Kramer's comments focus on the analysis of the benefits and costs of changes in tariffs on imported automobiles that are presented in the Charles River Associates report [1] but are not discussed in the conference paper included in this volume.

Because Kramer's comments do not relate directly to the analysis in this paper, they will not be evaluated in detail here. However, we disagree with much of Kramer's economic analysis and also with her policy conclusions. A few clarifying points about the CRA report merit brief mention:

- The CRA report used conventional tools of microeconomic analysis, as Kramer suggests. The measurement of the net welfare effects of higher tariffs was performed within the context of fixed aggregate demand (not necessarily full employment). The issue examined is whether there are net social gains from stimulating labor demand by auto import tariffs rather than by some more neutral method. The findings do not imply that there are net social losses from reducing aggregate unemployment.
- The conclusions of the CRA report do not depend on an assumption that the automobile industry is competitive. Both competitive and noncompetitive cases were simulated, with both showing net social costs from higher tariffs. (For the case of imperfect competition, see [1, pp. 337–48].)
- The use of a 10 percent price increase of imported automobiles in the simulations does not affect the qualitative conclusions. Assumption of a smaller price increase would have reduced both the auto industry employment gain *and* the resource allocation loss from a tariff, leaving their relative magnitudes similar.
- The price formation equations referred to by Dr. Kramer used import prices as the exogenous variables in some specifications and import shares in others. (See [1, pp. 194–209].) The findings from these equations—that higher import prices may lead to higher domestic auto prices—weaken the case for tariffs. However, the welfare computations in the competitive case were performed under the assumption that domestic auto prices are unaffected by exogenous increases in the prices of auto imports.
- Selected excerpts from the CRA report quoted by Dr. Kramer do not accurately represent the tone of the report. Readers interested in evaluating the methodology and conclusions of the benefit/cost analysis in the CRA report should consult the full study.

Dr. Triplett's comments are of a more technical nature, focusing mainly on the hedonic market share (HMS) model developed at CRA to analyze the impact of changes in relative prices of different automobiles on market share demand.

The authors have four major points of disagreement with Triplett:

1. Triplett's assertion that the HMS model ignores the theory of consumer demand is incorrect. The choice equation posited in the HMS model can be derived directly from the standard constrained maximization approach of consumer theory.

Using the standard approach, a consumer's utility may be written $V = V(u_j, F(z))$, where V is total utility from both the discrete good j (i.e., the automobile model chosen) and the collection of all other goods z. The consumer maximizes V subject to the budget constraint $I = P_j + P_z z$, where I is income, P_j is the price of the automobile model j, and P_z is the price index for all other goods.

Assuming either separability of utility between the automobile and other goods *or* constant relative prices within the set of all other goods, we can derive from this maximization problem the expression reported in the text, where the consumer chooses the automobile model j to maximize utility, which is a function of the price of j and the characteristics of j.

This point can be illustrated easily for the case of a linear utility function. The problem is to maximize

$$V = u_j + F(z) \tag{1}$$

Subject to

$$I = P_j + P_z z. \tag{2}$$

Solving (2) for z, and substituting in (1), we obtain

$$V = u_j + F((I - P_j)/P_z). \tag{3}$$

If the composite good is the numeraire, so that $P_z = 1$, and $F(z)$ is a linear function, the problem reduces to one of maximizing

$$V = u_j - P_j + I, \tag{4}$$

where u_j is a function of the characteristics of the automobile model chosen. In this linear version, the choice among discrete varieties does not depend on the consumer's income I, since income enters the utility function in the same way for each consumer.

Equation (4) is analogous to the utility function discussed in the text.

A similar, but slightly more complicated, derivation of the same general result can be performed for quadratic and logarithmic utility functions. In these formulations, the interpretation of the price coefficient is different (see [2, pp. 6–7]).

2. The alternative approach to the problem sketched by Triplett would not have helped to answer the questions raised by the study with the available data, and may not even be useful with a richer data set available. It is not clear from Triplett's comments how such a model can be applied to the problem at hand.

Triplett is disturbed that implicit prices derived from a hedonic price equation never appear in the HMS model. "Hedonic" prices are absent from the HMS model because the problem is posed as a choice among discrete alternatives, rather than as a series of demand equations for "characteristics." In the latter approach, suggested by Triplett, consumers are viewed as buying bundles of characteristics, with their choice constrained by the price of adding more units of a characteristic (for example, the price per pound of adding more weight to a car, other things fixed).

Triplett's approach has a number of theoretical and practical shortcomings. First, consumers cannot vary their combinations of characteristics continuously as the approach assumes; in the real world, they are limited to a finite number of models with given bundles of characteristics. Thus, characteristics are not exactly analogous to sets of uniform commodities, among which infinite combinations, within any budget constraint, can be chosen by the consumer. Incorporating the finite choice aspect of a problem explicitly makes the model more general and more difficult, as well as more realistic. The solution of this finite choice problem is the methodological advance in the HMS model. Second, the implicit prices discussed by Triplett can be meaningfully defined only under special conditions. These prices are derived by taking a regression of the total price of an automobile on its characteristics, usually using a cross-section of automobile models for a given year. If the form of the regression is properly linear, then the coefficient of each characteristic represents an estimate of its implicit price. However, if the hedonic function is nonlinear, as is likely to be the case, and has nonzero cross-product terms, the meaning of an implicit price becomes unclear. The marginal price of a characteristic then depends on the level of the characteristic being consumed; it is not longer just an external parameter confronting the buyer. Third, even if implicit prices could be sensibly defined in any year, it is not clear what Triplett would have the authors estimate. Presumably, in the U.S. automobile market, all buyers would face the same implicit price function for characteristics. How then would one estimate the effect of variations in price on the demand for characteristics?

Triplett's approach could not have been used in the study, even if it were a better general method, because data on auto purchases by individual consumers were not available to the authors. Even with disaggregate data on individual behavior, it might be much preferable to use a logit model approach, following the work already successfully applied in mode choice studies in the field of transportation demand. (For example, see [3].)

3. Triplett's long discussion about alleged contradictions in the results is largely irrelevant. The hedonic equations to which he refers are drawn from a section of the CRA report that attempted to make a rough comparison of "quality-adjusted" prices of imported and domestic automobiles in 1975. (See [1, pp. 81–82]). These are not the equations used to construct the price index in the time series regressions. Because those equations were not carefully specified, no implication was made in the CRA report that the *coefficients* should be interpreted as the marginal price of weight and horsepower. It is well known that when multicollinearity exists and proxy variables are used one should be careful about interpreting the meaning of coefficients. It is not clear why Triplett wants to make such an inference when the authors do not. In addition, the implied coefficient of weight in the HMS model represents the "mean" taste of *all* consumers. Contrary to Triplett's assertion, the use of that coefficient does not mean that the marginal value of consumers of an additional unit of weight is the same for both subcompacts and compacts, because buyers of subcompacts are different people who have different mean tastes than buyers of compacts.

4. Triplett's suggestions about the use of data in further research contain some factual inaccuracies. Contrary to Triplett's implication, the U.S. Environmental Protection Agency data on fuel economy were used in the HMS model, as were U.S. Department of Transportation data on acceleration. Weight is used in the HMS model as a proxy for several utility-producing attributes; these include such dimensions as luxuriousness, quietness and smoothness of ride, as well as, possibly, safety. Subjective measures of some of these dimensions are available in *Consumer Reports* for a limited number of models, but cannot be readily used in the HMS model, which requires data on a relatively complete set of the available choices.

The authors share Triplett's view that the right approach to studying market share demand for durable goods should incorporate an explicit quantitative analysis describing the factors behind consumer choice among competing models The HMS model developed for this study, in its present form, represents a preliminary step in this direction. The authors agree that much further work remains to be done and hope that research along these lines will be encouraged.

Literature Cited

1. Charles River Associates. *Impact of Trade Policies on the U.S. Automobile Market.* Final report submitted to Bureau of International Labor Affairs, U.S. Department of Labor, October 1976 (CRA report).
2. ———. "Methodology for Predicting the Demand for New-Electricity-Using Goods." Draft report submitted to Electric Power Research Institute, November 1976.
3. Domencich, T.A., and D. McFadden. *Urban Travel Demand: A Behavioral Analysis.* Amsterdam: North-Holland Publishing Company, 1975.

Rejoinder

Jack E. Triplett

Their reply indicates that Toder and Cardell (hereafter, T-C) did not understand my comments. Perhaps I was unclear.

1. I pointed out that there is an economic relationship between some of the parameter estimates of T-C's HMS market share model and the coefficients of their hedonic price study, and also that their HMS demand model could be thought of as a kind of "reduced form" of the general characteristics demand model popularized by Kelvin Lancaster [1]. These relationships were not discussed by the authors, and indeed have generally been ignored in the qualitative choice literature on which the HMS demand model is based. I was calling attention, in other words, to the fact that two sets of literature were proceeding somewhat independently on the same problem. The comparisons of parameters from their hedonic price function and their HMS model, which T-C feel were irrelevant (numbered point 3 in their reply), were simply a graphic way of demonstrating the interrelationships between techniques used in different parts of the study, and the reason for raising these issues was precisely that the authors did not.

I feel strongly that carrying out a direct analysis of behavior toward characteristics is an important step in establishing the economic framework which underlies the HMS model. However, the economics of the relationship between qualitative choice demand models, of which the HMS is an example, and Lancasterian characteristics demand models have not been thoroughly worked out. A recent paper by Anthony Lawrence [2], may be helpful to readers who want to go into the matter.

2. T-C feel there are "a number of theoretical and practical shortcomings" to alternative approaches. It happens that a number of the specific points they list (in their point # 2) are already covered elsewhere (see my paper on characteristics demand models [5] and my review of Lancaster [4]), and are not nearly the intractable problems they make them out to be.

T-C's one valid point is the paucity of data for carrying out nontraditional demand analysis, but this is a problem in implementing any alternative to the conventional approach to consumer demand, including the HMS model itself (see their listing of variables they would like to have, but couldn't get, in their point # 4). With respect to my original comment on the data question, I did not mean, in the paragraph in question (which was directed to "anyone who wishes to extend the approach") to imply that Toder had used none of the EPA-DOT data. Rather, I was urging that greater efforts be made to obtain data which measure characteristics directly, rather than variables which merely have some relation to what is desired. The serious problems which plague estimates based on proxy variables such as weight have been well known in the hedonic literature for years (see my 1969 paper [3]), and the HMS model did, as T-C themselves note in their "Reply," use precisely this troublesome proxy variable.

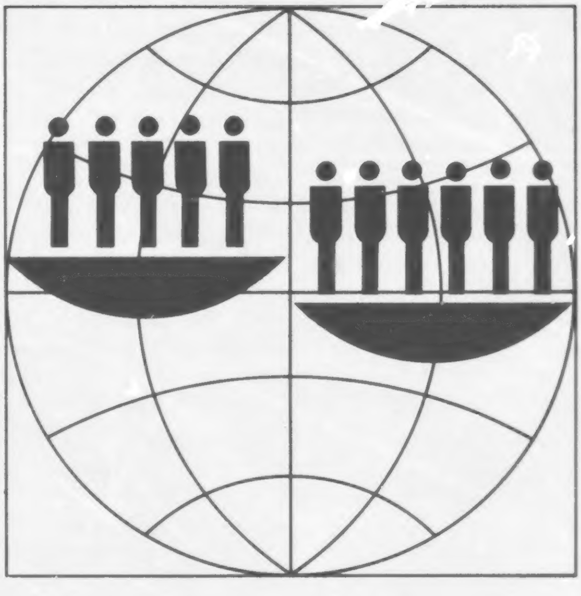
3. One should keep all this in the proper context. I certainly intended to convey in my comment on the T-C study my harmony with their general approach to the problem of estimating demand for heterogeneous goods. For the heterogeneous goods case, one must pay attention to the ways that varieties of goods differ and why consumers want the varieties they do in fact select; this the traditional approach to demand analysis does not and cannot do. To say that I would like to see improvements along certain lines in any subsequent attempts to follow the pioneering route T-C have set down was not intended to deny them credit for what I called "jumping off into uncharted and treacherous terrain."

Literature Cited

1. Lancaster, Kelvin. *Consumer Demand: A New Approach*. New York and London: Columbia University Press, 1971.
2. Lawrence, Anthony G. "The Role of Prices in Qualitative Choice Models." Unpublished paper, Energy Analysis and Environment Division, Electric Power Research Institute, Palo Alto, California, (revised) November 1976.
3. Triplett, Jack E. "Automobiles and Hedonic Quality Measurement." *Journal of Political Economy*, 77 (May/June 1969), 408-17.
4. ________ . "A Review of *Consumer Demand: A New Approach*, by Kelvin Lancaster." *Journal of Economic Literature*, 11 (March 1973), 77–81.
5. ________. "Consumer Demand and Characteristics of Consumption Goods." In *Household Production and Consumption*, edited by Nestor E. Terleckyj. Studies in Income and Wealth, vol. 40. New York: National Bureau of Economic Research, 1976.

Part Two

Labor Market Adjustments



Introduction

Harry J. Gilman

Policies designed to reduce restrictions on international trade have historically been supported on the grounds that the resultant increases in exports and imports would raise real incomes. The focus generally has been on the net income changes in trading countries and not on the distribution of income and on the costs of adjustment in reallocating resources to production in which they have a comparative advantage. Nevertheless, it is precisely these two aspects of the problem that are likely to influence the politics of trade liberalization.

Increases in imports from whatever source are likely to impose both monetary and nonmonetary costs on workers employed in import competing industries. For displaced workers who are reemployed in lines where their experience and specific skills are less valuable, the losses can be permanent. In fact, even workers lucky enough to be reemployed at comparable earnings will experience the permanent loss of foregone earnings and other costs involved in trying to find new positions.

The Brechling and Jacobson studies that appear in this section were motivated by the realization that previous studies in the trade area have largely ignored the labor market adjustment process. These new studies are complementary in the sense that each concentrates on a particular dimension of what is essentially a many-sided problem. Brechling examines the way in which reductions in employment occur in response to declines in output; Jacobson estimates the earnings loss incurred by workers displaced from particular manufacturing industries, eleven all told. Though their findings are far from definitive, both provide new and significant insights into the labor market adjustment process.

Brechling's major finding is that the primary method of reducing employment in a particular industry in response to a fall in demand for its output is through displacements rather than through natural attrition, though this important finding holds only if relative wages in expanding industries don't simultaneously rise. Brechling is aware that his particular model does not apply as well to the case of trade liberalization as one would like. Nevertheless, his work provides important new insights into complex labor market dynamics that necessarily accompany any restructuring of labor demand among firms and industries.

Jacobson estimates monetary losses incurred by workers displaced from particular industries which heretofore have simply not been estimated systematically. Economists addressing the issue of displacement costs sometimes equated these costs with earnings foregone during the period of unemployment and ignored the possibility of lower reemployment wages. But even if they considered reemployment wages, they associated the wage loss with the difference between the wages earned prior to the job loss with those earned immediately after reemployment. As Jacobson points out, these economists have generally ignored the secular patterns of earnings of reemployed workers, which may be very different from those of continuously employed workers. Jacobson's estimates took their secular wage pattern into account. Jacobson was also able to improve the quality of the estimates by using social security data for individuals classified by the employer's industry—the so-called LEED file.

Jacobson's major findings:

- Displaced workers often bear substantial costs beyond these imposed during the initial period of unemployment.
- These added costs are likely to vary substantially among industries, depending among other things on the differences in the skill levels of workers in those industries.

As is always true of empirical work, there is a lot more that could be done to improve these studies. Indeed in the comments by Richard Freeman and those by me that appear after the Brechling and Jacobson papers, there are a variety of detailed suggestions that provide an agenda for future work on the very interesting and important topic of labor adjustment to shifts in the demand for labor by firms and industries.

A Time Series Analysis of Labor Turnover

Frank Brechling*

1. Introduction

Import penetrations of markets typically necessitate reductions in the employment levels of the affected domestic suppliers. These net reductions in employment can be subdivided conveniently into *displacements* and *unreplaced attritions*. Displacements are permanent separations initiated by employers and attributable to the import penetration. Attritions are all other permanent separations that may be due to voluntary quitting, retirement, death, disability, incompetence, or dishonesty. When employers refrain from replacing attritions they are termed unreplaced attritions. The essential difference between displacements and attritions arises from the nature of their costs. Displacements involve unexpected costs that, in the absence of compensation for them, must be borne involuntarily by the displaced workers. The costs of attritions, on the other hand, are anticipated and borne voluntarily by workers as part of the normal costs of obtaining and leaving jobs.[1] For this reason it is often suggested that displaced workers be compensated for their displacement costs, especially if the import penetration is attributable to a change in governmental policy. In the United States some compensation for displacement costs is provided for under the trade adjustment assistance program of the 1974 Trade Act.

The aim of the research underlying this paper has been to obtain estimates of displacements and unreplaced attritions in industries that experience permanent net reductions in employment. Such information may be helpful in the formulation of trade policies as well as for the evaluation of the trade adjustment assistance program.[2]

Several data bases have been used for the computation of displacements and unreplaced attritions.[3] In the research underlying the present paper, the *time series* data on labor turnover by industry published by the Bureau of Labor Statistics have been used. In part 2 of this paper a conceptual framework for and a description of these statistics are presented. The conceptualization of the labor turnover relationships also yields formal, operationally meaningful expressions for displacements and unreplaced attritions.

For the estimation of displacements and unreplaced attritions a model is required within which these labor flows or their components are linked to their determinants, in particular, to net changes in employment. Part 3 of this paper is devoted to the description, derivation, estimation and simulation of labor turnover models. This part is subdivided into four sections. In section 3A a turnover model with *exogenous quits*, which was developed and fitted by a previous investigator, is presented and its implications for displacements and unreplaced attritions are described. This model and the appropriate parameter estimates suggest that 79 percent of any net reduction in employment is accomplished by unreplaced attritions and only 21 percent by displacements.

These estimates of unreplaced attritions and displacements, however, depend crucially on the assumption of exogenous quits. By contrast, the model, which has been used in the major part of the research underlying this paper, incorporates quits as an *endogenous*

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*I am deeply indebted to my colleagues at the Public Research Institute for many helpful discussions of the seemingly insuperable problems encountered in the research underlying this paper. Kathy Classen, William Dewald, Paul Feldman, Harry Gilman, and Bruce Vavrichek read a previous draft of this paper and made many valuable comments. Their help is acknowledged gratefully. This paper is based on Frank P. Brechling "A Time Series Analysis of Labor Turnover," ILAB 75-19 which was completed in 1976.

[1] Costs of displacements and attritions have been estimated by Bale [1] and Jacobson [10].

[2] Although the research has here been motivated in terms of the consequences of trade liberalization measures, estimates of displacements and unreplaced attritions may be useful for many other purposes. Suppose, for instance, that a net reduction in employment is brought about by a regulation designed to protect the environment. The costs incurred by displaced workers would be a legitimate cost of the implementation of the regulation and, hence, it would be important to know the level of displacements and unreplaced attritions.

[3] See, for instance, Jacobson [9] who used Social Security data to estimate displacements and attritions in the steel industry.

variable. This model, which is described in section 3B, consists of several dynamically interdependent equations, designed to describe the behavior over time of all the relevant labor turnover categories.

The labor turnover model with endogenous quits has been fitted to the data for twenty-four manufacturing industries, but section 3C contains the empirical results for only two groups, namely total durable and total nondurable goods industries. The results lend considerable empirical support to the model with endogenous quits. The equations explaining new hires and layoffs by firms conform to the data especially well.

Since it is difficult to ascertain the full implications of a model that consists of several dynamically interdependent equations by analytical methods, its main implications for displacement and unreplaced attritions have been obtained by a simulation exercise. The industry in question is assumed to be initially in equilibrium and then it is disturbed by a permanent 10 percent reduction in output. The ensuing paths of employment and the labor turnover categories are then traced and estimates of displacements and unreplaced attritions are made. The results for total durable and total nondurable goods industries are reported in section 3D. They suggest that unreplaced attritions play only a secondary role in effecting net reductions in employment. Of four different estimates of unreplaced attritions, the highest one is 43 percent of the net reduction in employment, which is substantially below the 79 percent implied by the model with exogenous quits. The failure of unreplaced attritions to bring about much of the net reduction in employment occurs in spite of large reductions in new hires and is due to the sharp decline in voluntary quits. In other words, a decline in the demand for an industry's output and, hence, for labor discourages attritions so strongly that, despite large reductions in replacements, the level of unreplaced attritions cannot rise much.

In part 4 of this paper the main conclusions and major desirable extensions of the research are highlighted. The empirical results suggest that the extent to which costless unreplaced attritions can bring about net reductions in employment may be quite limited and this conclusion may well be at variance with the views held commonly by labor economists. To be sure, many problems of conceptualization, estimation, and interpretation remain to be solved. In particular, it seems desirable to disaggregate the data and to estimate and simulate models for many industries.

2. Concepts and Definitions

In part 2 the basic concepts and definitions of labor turnover as well as the main characteristics of the data used in the analysis are described. Such a description is a suitable introduction to the discussion of labor turnover models in part 3. The main labor turnover relationships are discussed in section A, and section B contains a description of the time series data.

A. The Basic Labor Turnover Relationships

Figure 1 illustrates the relationships among an industry's various gross and net flows of labor. Accessions A are all permanent and temporary additions to the payrolls of establishments in a specified time period. Separations S are all terminations of employment at establishments during the period. Thus accessions and separations measure the gross inflows and outflows of labor. Consequently the net change in employment equals the difference between accessions and separations

$$\Delta N = A_t - S_t, \tag{1}$$

where ΔN measures the net change in employment in period t.

It is helpful to distinguish between two main flows of labor in Figure 1. First, there is the upper counterclockwise flow, which contains workers who have been laid off. Layoffs L are terminations of employment, initiated by the employer because of economic conditions, such as lack of orders, and without prejudice to the employees. Laid-off workers initially join and, hence, raise the stock of laid-off employees SL who qualify for and are awaiting recall by their previous employers. Workers who leave the stock of laid-off employees may (1) be rehired by their previous employers and included in RH, a component of A, (2) be newly hired by other employers in the same industry and included in NH_1, a component of A, or (3) leave the industry altogether and be included in DIS_1. This basic identity among the variables can be stated formally:

$$L_t = \Delta SL + RH_t + NH_{1t} + DIS_{1t}, \tag{2}$$

where ΔSL stands for the net increase in the stock of laid-off workers in period t.

Two concepts of displacements can be derived from equation (2). First, displacements can be measured by DIS_1, the number of laid-off workers who leave the industry:

$$DIS_{1t} = L_t - \Delta SL - RH_t - NH_{1t}. \tag{3}$$

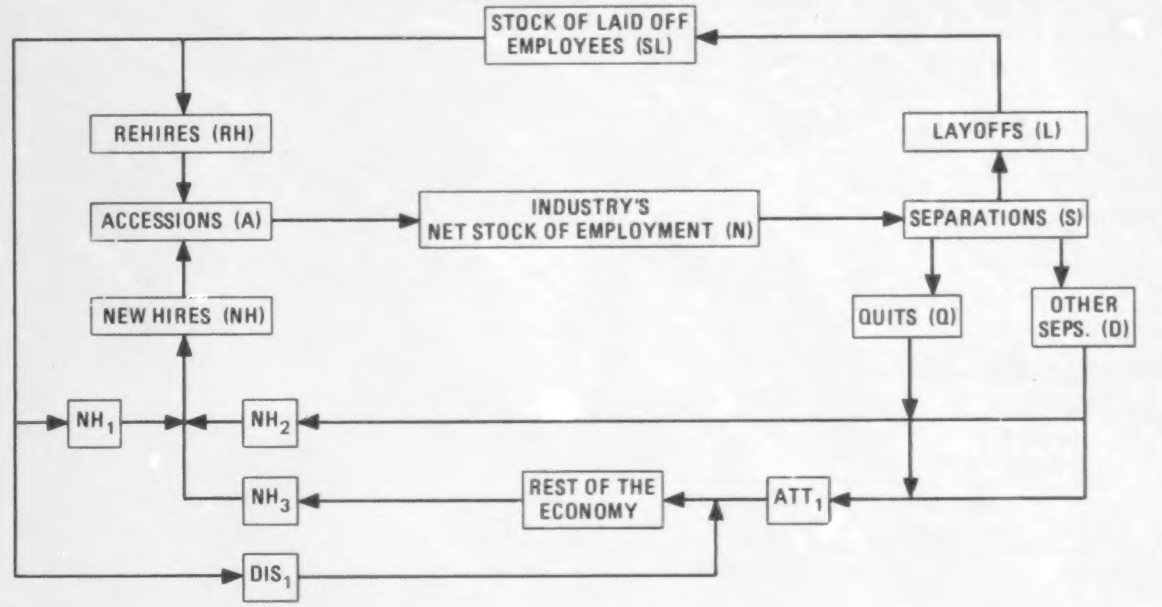

Figure 1
Gross Flows of Labor into and out of an Industry

Second, displacements can be measured by DIS, the number of workers who leave the industry plus the increase in the stock of laid-off workers:

$$DIS_t = DIS_{1t} + \Delta SL = L_t - RH_t - NH_{1t}. \quad (4)$$

The second basic flow of labor in Figure 1 is the lower clockwise one which contains quits Q and other separations D. Quits are terminations of employment initiated by employees for the purpose of changing to another job, searching for another job, or leaving the labor force. Other separations include discharges for reasons such as incompetence or dishonesty, as well as terminations due to retirement, death, and physical disability. Workers who are classified as quits or other separations may (1) find jobs in the same industry and appear in NH_2, a component of A, or (2) leave the industry and appear in ATT_1. This identity can be written as:

$$Q_t + D_t = NH_{2t} + ATT_{1t}. \quad (5)$$

As shown in Figure 1, total new hires consist of three components: laid-off workers who are hired by *new* employers in the same industry NH_1, workers in quits and other separations who find a job in the same industry NH_2, and workers who are hired from outside the industry NH_3:

$$NH_t = NH_{1t} + NH_{2t} + NH_{3t}. \quad (6)$$

The concept of unreplaced attritions can now be defined in terms of the labor turnover categories. For an industry, unreplaced attritions ATT measure the number of workers, classified as quits and other separations who leave the industry and are not replaced by new hires from outside the industry:

$$ATT = ATT_{1t} - NH_{3t}, \quad (7)$$

or, because of equations (5) and (6)

$$ATT_t = Q_t + D_t - NH_t + NH_{1t}. \quad (8)$$

By adding equations (4) and (8) it can easily be established that the sum of DIS and ATT must equal the net reduction in employment.

$$\begin{aligned} DIS_t + ATT_t &= (L_t+Q_t+D_t) - (NH_t+RH_t) \\ &= S_t - A_t = -\Delta N. \end{aligned} \quad (9)$$

Similarly, by adding equations (3) and (8) it can be shown easily that the sum of DIS_1 and ATT must be equal to $-\Delta\ (N+SL)$.

B. The Time Series Data

The Bureau of Labor Statistics, in collaboration with the state employment security agencies, collects and publishes five monthly labor turnover series for 191 manufacturing industries. These five series are accessions, new hires, separations, quits, and layoffs.[4] The definitions used for these concepts by the BLS are virtually identical to those presented in the previous section.

Absolute numbers for the five turnover categories are obtained by the BLS each month for a sample of establishments in each industry. These figures are then converted into percentages by dividing them by the total number of employees who are on the sampled establishments' payrolls during the week containing the twelfth day of the month. The monthly percentage turnover series are published in *Employment and Earnings*.

For the purpose of the empirical research underlying the present paper, the published BLS turnover rates were converted into absolute numbers and then cumulated over three months, so that the basic data set consists of *quarterly absolute turnover levels*. Three other turnover series were constructed from the basic data set: rehires, other separations, and the stock of laid-off workers. Let us discuss these series in turn.

(1) Rehires were computed as the difference between accessions and new hires, or $RH = A-NH$. Because of the BLS definitions, this concept of rehires includes not only recalls of laid-off workers but also transfers from other establishments of the same company and employees returning from military service or unpaid leaves of absence.

(2) Other separations were computed as the difference between total separations and the sum of layoffs and quits, $D = S-Q-L$. Thus, other separations include dismissals initiated by the employer for reasons such as incompetence or dishonesty, as well as terminations due to military service, retirement, death, physical disability, and transfers to other establishments of the same company.

(3) The stock of laid-off employees SL is somewhat more complicated to compute than that of rehires and other separations. The gross inflow into SL consists of layoffs and part of the gross outflow consists of rehires. But unfortunately there is no published information on the other part of the gross outflow which in Figure 1 is measured by $NH_1 + DIS_1$. Hence, the other part of the gross outflow was assumed to be a constant proportion δ of the stock of laid-off workers. Let SL_t stand for the stock of laid-off employees at the end of period t. The following equation then describes how SL_t is determined by SL_{t-1}, δ, L_t, and RH_t:

$$SL_t = (1-\delta)SL_{t-1} + (L_t-RH_t), \qquad (10)$$

where L_t-RH_t measures the net layoffs in period t and and $(1-\delta)SL_{t-1}$ the number of employees in the stock both at the beginning and at the end of period t. Equation (10) implies that $NH_1+DIS_1 = \delta SL_{t-1}$. In order to compute SL_t assumptions have been made about the size of the initial stock SL_0 and the proportion δ. The initial stock was assumed to be approximately equal to the mean layoffs for a period of one to three months and the proportion δ was chosen between 0 and 0.3. These two assumptions permit the computation of a time series for SL_t. In the actual calculations SL_t was expressed as a proportion of the labor force, $SL_t/(SL_t + N_t)$. The assumptions about SL_0 and δ were changed until plausible time series for this proportion were generated. The occurrence of negative SL_t's proved to be a particular problem. In some industries rehires are so large in relation to layoffs that negative SL_t's could be avoided only by very large SL_0's and small δ's.[5]

No data are available or could be generated for some of the labor turnover categories mentioned in the description of Figure 1. In particular, no information exists on NH_1, NH_2, NH_3, DIS_1, and ATT_1. The lack of data on NH_1 is especially unfortunate because it plays a potentially important role in the definition of displacements and unreplaced attritions in equations (3), (4) and (8). In the actual computations of DIS_1, DIS, and ATT, it was necessary, therefore, to assume that $NH_1 = 0$. Moreover, since it is often appropriate to measure the labor turnover flows as *deviations* from some equilibrium or steady-state level, NH_1 need not necessarily be positive and, hence, nothing can be said about the direction of the bias in DIS_1, DIS, and ATT, which is caused by the omission of NH_1.

In order to give the reader an impression of the rough order of magnitude of the time series data on labor turnover, Table 1 has been prepared. It shows the sample means of the net change in employment and all the

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[4] According to the questionnaire, which is sent to the sample of firms, form DL1219, the BLS requests and receives information also on a sixth turnover category, namely, discharges. This series, however, is not published separately.

[5] In a recent paper, Parsons and Fleisher [16] have argued that δ should be allowed to fluctuate over the business cycle. Moreover, their preliminary calculations seem to suggest that δ is significantly higher in prosperous than in depressed times. The above assumption of a constant δ is thus undesirable but unfortunately apparently unavoidable until better data become available.

Table 1

Mean Quarterly Turnover and Employment Variables for Total Durable and Nondurable Goods Industries

	Durables	Nondurables
Net change in employment, $\Delta N/N$ in percent	0.16	0.15
Accessions, A/N in percent	11.85	13.92
New hires, NH/N in percent	8.11	9.83
Rehires, RH/N in percent	3.74	4.09
Separations, S/N in percent	12.35	14.15
Quits, Q/N in percent	5.25	6.88
Layoffs, L/N in percent	4.47	5.11
Other separations, D/N in percent	2.62	2.16
Accessions-separations, $(A-S)/N$ in percent	−0.50	−0.23
Error in data, $Z/N = (\Delta N - A + S)/N$ in percent	0.66	0.38
Mean employment stock, N in thousands	10,705	7,750
Mean stock of laid-off employees, SL in thousands	518	258

Sample Periods: 1960.II to 1975.IV for durable goods industries; 1958.II to 1974.IV for nondurable goods industries.

labor turnover flows as percentages of the sample mean of the employment stock.[6] The latter and the mean stock of laid-off employees are also presented. The following characteristics of the data are worth noting.

First, the turnover flows are all quite large in relation to the net changes in employment. In particular, the sums of quits and other separations, which amount to 7.9 and 9.0 percent for the two industry groups, seem sufficiently large to suggest that unreplaced attritions are capable of playing an important role in effecting net reductions in employment levels.

Second, there seems to be an internal inconsistency in the data, which may cause problems in both the empirical estimation and the interpretation of the empirical results. According to equation (1), the net change in employment is equal to the difference between accessions and separations. However, the figures in Table 1 show that on average $A-S$ is negative and ΔN is positive. The percentage errors Z/N in the data amount to 0.66 and 0.38 for the durable and nondurable goods industries respectively. In absolute numbers these differences amount to just under 70,000 and 30,000 workers for the two industry groups. Although this inconsistency between the labor turnover and employment stock data has been recognized before, relatively little is known about its causes and sources.[7] In the empirical analysis underlying the present paper, the inconsistency in the data has been treated in two ways. In one it has been allowed to exist, so that the identity $\Delta N = A-S$ is not imposed in the empirical estimation. In the other the difference between ΔN and $A-S$ has been attributed alternatively to displacements or to unreplaced attritions so that the identity has been made to hold in the empirical estimation.

Third, rehires tend to be quite large in relation to layoffs. Thus, for both industry groups rehires average more than 80 percent of layoffs. This evidence suggests that, at least for the sample period under consideration, a large proportion of layoffs are temporary in the sense that they do not involve the severance of long-run employer-employee relationships.

3. Models of Labor Turnover

Relatively little research has been undertaken on the *time series* behavior of labor turnover in U.S. manufacturing industries.[8] Further, three previous investigators confined their analyses to only one labor turnover category: Barth [2] studied only layoffs; Mattila [11] and Parsons [15] only quits. For present purposes the previous work by Hamermesh [8] is the most relevant. For this reason his approach has been studied in detail as part of the research underlying the paper and the findings are summarized in section A.[9] In section B an altenative model is presented, which is similar in spirit to Hamermesh's but differs from it in crucial respects. It is estimated in section C and simulated in section D.

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[6] For the computation of the net change in employment, it is necessary to obtain an estimate of the level of employment at the end of the quarter. These estimates were obtained by computing the mean of the employment levels in the last month of the quarter in question and the first month of the following quarter. Thus employment at the end of, for instance, the first quarter was set equal to the mean of the March and April employment levels.

[7] The difference between ΔN and $(A-S)$ is frequently attributed to the under-reporting of rehires, but this explanation does not seem to be wholly satisfactory because in many industries rehires are already very large in relation to layoffs.

[8] There are, however, quite a number of excellent *cross-section* analyses of labor turnover, of which the ones by Burton and Parker [6], Hall [7], Parsons [14], Pencavel [17, 18], and Stoikov and Raimon [19] seem to be the most noteworthy. One other interesting recent contribution is that by Toikka [20]. He uses time series data to study the probabilities of movements between employment, unemployment and nonparticipation. Toikka's main focus is his labor force participation, which is different from, but related to, the focus of the present study, namely the determinants of displacements and unreplaced attritions.

A. A Labor Turnover Model with Exogenous Quits

This section contains a condensed version of a working paper [4] in which Hamermesh's approach is analyzed and its implications for unreplaced attritions and displacements ascertained by means of simulation experiments.[10]

Hamermesh's model consists of the following five equations:

$$\log n = \alpha_0 + \alpha_1 \log n_{-1} + \alpha_2 X + \alpha_3 \dot{y}, \qquad (11)$$

$$\log l = \beta_0 + \beta_1 \log l_{-1} + \beta_2 X + \beta_3 \dot{y}, \qquad (12)$$

$$oa = \gamma_0 + \gamma_1\, oa_{-1} + \gamma_2 l_{-2}, \qquad (13)$$

$$os = \eta_0 + \eta_1\, n_{-2}, \qquad (14)$$

$$q = \mu_0 + \mu_1 (1/u^2) + \mu_2 \dot{u}, \qquad (15)$$

where n, l, oa, os, and q stand for new hires, layoffs, other accessions, other separations, and quits, all measured as percentages of the employment stock. Further, $\dot{y}$ is the percentage change in output, u is the national unemployment rate, and $X = q - oa + os$. The time period to which the subscripts refer is one month.

For present purposes, two aspects of Hamermesh's model should be emphasized. First, crucial relationships have been specified entirely in terms of the proportionate growth rates of employment and output. Hence, the model does not yield any nontrivial comparative static predictions about the *level* of employment. Moreover, the actual level of current employment is not allowed to have an influence on labor turnover, so that, for example, new hires must rise with output growth, no matter whether the firm's *current level* of employment is excessive or deficient.

Second, quits are postulated to depend only on the national unemployment rate and its change, which are independent of the activities of the small industry the model describes. Thus quits are really assumed to be exogenous. This assumption is important for the computation of unreplaced attritions for the following reason: If quits are independent of the industry's activities, then a reduction in employment can be brought about relatively easily by reductions in new hires. If, by contrast, quits should *decline* in response to reductions in demand, then firms would have to offset these declines by further reductions in new hires in order to bring about a given cut in employment through unreplaced attritions, and firms may find it difficult to accomplish this.

Hamermesh's model, with his own parameter estimates, was simulated for several industries. For brevity, the results for only one industry, iron and steel foundries (SIC 332), are sketched here. Initially the industry is assumed to be in the steady state, which is generated by an output growth of 0.6 percent and a quit rate of 1.27 percent per month. These numbers are approximately equal to the average output growth and quit rate for Hamermesh's sample period. In the simulation the output growth then declines to −1.0 percent for a period of twelve months, after which it returns to its former level. The cumulative permanent reduction in output *below its initial growth path* is thus about 20 percent. The simulation has shown that, as a consequence of this assumed disturbance, employment must also fall *below its initial growth path* until the total reduction is about 8 percent. How is this reduction in employment brought about? The simulation provides the following answers: For every 1 percent reduction in employment (1) new hires fall by 0.93 points, (2) layoffs rise by 0.51 points, (3) rehires rise by 0.30 points and (4) other separations fall by 0.14 points.[11] Since quits are not allowed to vary, these numbers imply that *displacements account for 21 percent and unreplaced attritions for 79 percent of the net reduction in employment.*[12]

Thus the present analysis of the implications of Hamermesh's model for unreplaced attritions and displacements has led to the conclusion that unreplaced attritions may play a major role in bringing about reductions in employment. But this result depends crucially on the invariance of quits. What would happen if quits should fall with reductions in the demand for labor? In the next three sections an attempt is made to answer this question.

B. A Model with Endogenous Quits

In this section a labor turnover model is presented, which is similar in spirit to Hamermesh's but differs from it in crucial respects. In particular, the level of employment is now allowed to influence labor turnover and quits are no longer independent of conditions within the industry.

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[9] The detailed results of this study of Hamermesh's model are contained in a working paper [4], which is available on request.

[10] Hamermesh did not construct his model with the aim of simulating it or of obtaining its implications for displacements and unreplaced attritions. Hence, he should not be held responsible for the methods or results of this part of the analysis.

[11] These figures are cumulated percentage deviations of the labor turnover flows from their initial steady-state levels.

[12] Displacements and unreplaced attritions are defined as $DIS = L - RH$ and $ATT = Q + D - NH$, where all variables are measured appropriately as cumulated deviations from their initial steady-state levels. But the estimates of DIS and ATT may contain biases because NH_1 has been omitted from both.

In the present framework, labor turnover actions are initiated by either employers or employees or caused by entirely autonomous factors such as military conscription, the compulsory retirement age, or ill health. Let us examine in turn the decision problems faced by employers and by employees.

(1) Employers are assumed to treat their voluntary quits and other separations as exogenous and to control their accessions (new hires plus rehires) and layoffs so as to bring about a net change in employment that is also endogenous and determined by the demand for the firm's output and similar conditions. Let us assume, for the present argument, that the employing unit is so small that all its employees are homogenous. The quantity $x_i = \Delta N_i + Q_i + D_i$ then measures the ith employer's deficiency of employees if $x_i > 0$ or surplus if $x_i < 0$. For such small employers it would not be optimal to *both* hire *and* lay off employees. Consequently when $x_i \geqslant 0$, then $A_i = x_i$ and $L_i = 0$; and when $x_i \leqslant 0$, then $L_i = -x_i$ and $A_i = 0$. The definition of x_i also implies that both A_i and L_i are related linearly to ΔN_i, Q_i and D_i, the former positively and the latter negatively. In contrast to this microtheoretic prediction that there should be *either* accessions or layoffs but not both, virtually all the available data on labor turnover show that both accessions and layoffs are quite large in all phases of the business cycle. This phenomenon is likely to be due to the fact that the data refer to more than one employing unit as defined above, so that employing units with both positive and negative x_i are aggregated. Let us, therefore, consider briefly how aggregation might affect the relationships among A, L, ΔN, Q, and D.

Let the x_i be distributed according to the discrete frequency function $f(x)$. Total industry layoffs, defined as a positive number, are then simply the sum of all negative x's, and similarly accessions are the sum of all positive x's:

$$L = \sum_{x=x_0}^{x=0} x\, f(x). \tag{16}$$

$$A = \sum_{x=0}^{x=x_1} x\, f(x) \tag{17}$$

where x_0 and x_1 are the lower and upper limits of the observed x's. The sum of all x's in the industry is denoted by X and can be expressed as

$$X = \sum_{x=x_0}^{x=x_1} x\, f(x) \tag{18}$$

It follows that $X = A - L$. Moreover, since $x_i = \Delta N_i + Q_i + D_i$ is a linear relationship, it can be aggregated so that $X = \Delta N + Q + D$ and, hence, $\Delta N = A - L - Q - D$, which is the basic identity expressed in equation (1).

Let us now consider the relationships between the aggregate variables X, A, and L. Suppose, for instance, that the x's for all micro units rise by an identical amount, so that the entire $f(x)$ distribution shifts to the right. Two effects of this shift can be distinguished: First, there are now *fewer* negative and *more* positive x's and, second, all the remaining negative and positive x's are higher than before. Both effects operate in the same direction. In aggregate, L must fall and both A and X must rise. Although the identity $\Delta N = A - L - Q - D$ must hold both before and after the rise in the x's, there is no reason to believe that the relationships between X and A or X and L are simple linear ones. Experimentation with even simple $f(x)$ functions tends to result in complex nonlinear aggregative relationships.

According to the above analysis, aggregate accessions and layoffs should both depend on aggregate ΔN, Q, and D, the former positively and the latter negatively. These predictions have been derived from the basic identity $x_i = \Delta N_i + Q_i + D_i$ and, as long as this identity holds exactly, all determinants of A and L must be reflected by ΔN, Q, and D, so that no additional factors can exert an influence on A and L. As has been mentioned in part 2, the time series data, which have been used in the empirical analysis, do not satisfy the identity exactly. In order to formalize this peculiarity of the data, let us introduce an error term Z, which brings about the identity *in the data*. In other words, Z is defined by $\Delta N = A - L - Q - D + Z$. The evidence of Table 1 suggests that Z is, on average, positive. With given ΔN, Q, and D it is now possible that A and L be influenced by additional factors that operate through Z. For instance, some determinant may raise both Z and L and leave ΔN, Q, and D unaffected. Since not much is known about the nature of Z, it is not easy to theorize about its determinants. At this stage it is only recognized that there may be determinants of A and L that are not reflected by ΔN, Q, and D but operate through Z.

So far, only total accessions and layoffs have been examined and nothing has been said about the determination of the components of accessions, namely new hires and rehires. Let us turn to this problem. Given that accessions A_i at the microeconomic level are positive, it seems plausible that employers first of all rehire their previously laid-off but still available employees until their own stocks of laid-off employees SL_i are exhausted and only then, if indeed $A_i > SL_i$, do they hire new employees. The reason for this behavior is quite simple: SL may be viewed as a secondary work force from which employers can add to their employment stocks rapidly and at a relatively low cost of hiring, training, and phasing in. If, at the microeconomic level, employers are distributed over various SL_i (for $SL_i > 0$), then an aggregation argument similar to that used in the previous two paragraphs can be used to obtain the following aggregate prediction: At a given level of aggregate accessions A, a rise in aggregate SL should lead to a rise in aggregate rehires RH and a fall in aggregate new hires NH. Moreover, in aggregate, at a given level of SL, a rise in A should increase both NH and RH. The effect on RH should become weaker as A rises and more and more employers exhaust their own stocks of laid-off workers SL_i.

By way of summary, let us express the determination of aggregate new hires, rehires, and layoffs in formal terms:

$$NH = f_1 (\Delta \overset{+}{N}, \overset{+}{Q}, \overset{+}{D}, \overset{-}{SL}), \tag{19}$$

$$RH = f_2 (\Delta \overset{+}{N}, \overset{+}{Q}, \overset{+}{D}, \overset{+}{SL}), \tag{20}$$

$$L = f_3 (\Delta \overset{-}{N}, \overset{-}{Q}, \overset{-}{D}, SL), \tag{21}$$

where the signs above the variables indicate the direction of their theoretically expected influence upon NH, RH, and L. For the sake of generality, SL has been included also in the layoff equation. This can be justified only on the grounds that SL is a determinant of the error term Z, but no sign prediction can be made. Equations (19) to (21) can also be rearranged to yield expressions for the two variables that are of primary interest, displacements and unreplaced attritions:[13]

$$DIS = L - RH = f_4 (\Delta \overset{-}{N}, \overset{-}{Q}, \overset{-}{D}, \overset{-}{SL}), \tag{22}$$

$$ATT = Q + D - NH = f_5 (\Delta \overset{-}{N}, Q, D, \overset{+}{SL}). \tag{23}$$

As mentioned, employers are envisaged, within the present framework, to regard their quits and other separations as exogenous and to take a *joint* decision on new hires, rehires, layoffs, and the net change in employment. Having discussed the determination of new hires, rehires, and layoffs, let us now turn to a description of the *net* demand for labor. There exists an extensive literature on net employment functions. The particular version of employment function proposed here is similar to the one derived by Brechling and Mortensen [5], Brechling [3], and Nadiri and Rosen [13]. It is part of a multivariate stock adjustment model in which employment N, real inventories I, and unfilled orders U are determined. The comparative static levels N^*, I^*, and U^* are determined, through a cost minimization procedure, by real orders OR, the real wage rate w, technological change represented by a time trend t, quits Q, other separations D, and the stock of laid-off workers SL. The net employment function can be written formally as:

$$\begin{aligned} \Delta N &= \overset{+}{m}_1 (N_t^* - N_{t-1}) + \overset{+}{m}_2 (I_t^* - I_{t-1}) \\ &\quad + \overset{-}{m}_3 (U_t^* - U_{t-1}), \end{aligned} \tag{24}$$

$$N_t^* = g_1 (\overset{+}{OR}, \overset{-}{w}, \overset{-}{t}, \overset{+}{Q}, \overset{+}{D}, \overset{-}{SL}), \tag{25}$$

$$I_t^* = g_2 (\overset{+}{OR}, \overset{+}{w}, \overset{-}{t}, Q, D, SL), \tag{26}$$

$$U_t^* = g_3 (\overset{+}{OR}, \overset{+}{w}, \overset{-}{t}, Q, D, SL). \tag{27}$$

As before, the signs over the coefficients or variables indicate the plausible directions of the influences of the exogenous variables. Most, but not all, of these signs are implied unambiguously by the theory, as is shown in the studies cited. The influence of Q, D, and SL upon N^* requires special comment. As Q and D rise with constant real orders, employees have to be replaced more frequently; this implies a rise in the cost of labor and hence, a tendency for N^* to fall. But the rise in Q and D also implies an increase in the proportion of employees who are being trained and phased in at any time and thus a reduction in the average level of training of the employees and this effect tends to raise N^*. In equation (25) the second effect is assumed to dominate. The negative influence of SL upon N^* is based on a proposition put forward by Barth [2]: If firms regard SL as a kind of secondary labor force that is used as a buffer in cyclical adjustments, then a rise in SL reduces the probability that this buffer will be exhausted, and consequently firms reduce their comparative static employment levels N^*.

It should perhaps be emphasized that equation (24) is only one of three dynamically interdependent equations. The other two relate ΔI and ΔU to the same independent variables through related parameters. The omission of these two equations means that the individual parameters of equations (25) to (27) cannot be identified and hence the sign predictions discussed above cannot be tested. Further, the omission of the equations for ΔI and ΔU requires some special assumptions in the simulation exercise reported in section D.

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[13] As has been pointed out in part 2 of this paper, these expressions for DIS and ATT are only approximately correct: DIS includes but should exclude NH_1, and ATT excludes but should include it. Typically DIS must be expected to be too high and ATT too low. No attempt has been made to estimate empirically the other displacement concept, namely $DIS_1 = L - \Delta SL - RH$ and, hence, it is not dealt with explicitly in this part of the paper.

(2) Having described employer's behavior, let us turn to a discussion of the remaining two labor turnover categories, quits Q and other separations D. Quits are initiated by employees whose decision to quit their present positions depends on their quit propensities and the attractiveness of their present positions in relation to alternatives. In particular, the absolute level of quits in an industry is assumed to depend on the following seven factors. First, the initial total level of employment N_{t-1} should have a positive effect on quits Q_t which, however, need not be equiproportionate. Second, the industry's wage in relation to the mean wage in all other industries w/w_o should have a negative influence on Q_t. Third, the industry's employment growth ΔN should affect quits negatively. A rise in ΔN is expected to imply a reduction in the probability of being laid off and, hence, to make jobs within the industry more attractive. Fourth, a rise in the employment growth of all other industries ΔE should make alternative industries relatively more attractive and raise quits. Fifth, the number of low-tenure employees in the industry is expected to have a positive effect on total industry quits. The reason for this effect is that low-tenure employees tend to have very high quit propensities, a phenomenon consistent with the theoretical argument that employees learn about the nonpecuniary aspects of their jobs at low tenure levels and quit when they find them unattractive. Unfortunately, no series of the tenure distributions of employees are published for the current sample of industries. Consequently, of various proxy variables considered, it was decided to use the recent growth in employment. In particular, Wi is defined as the growth in employment over the past i quarters prior to the beginning of the current quarter: $Wi = N_{t-1} - N_{t-1-i}$, which is expected to have a positive impact on total quits. The *current* employment change ΔN might, however, also be a good indicator of the numbers of low-tenure employees and thus exert a positive effect on quits. This positive effect might outweigh the negative effect of ΔN discussed above. Sixth, the stock of laid-off workers SL_{t-1} at the beginning of the quarter may also have a negative influence on quits. A rise in SL_{t-1} should discourage those quitters who normally find new jobs within the *same* industry because SL_{t-1} is a measure of job availability within the industry. Seventh, in order to represent any omitted variables, a time trend t was also allowed to play a role in the determination of total quits. In formal terms, the proposed quit function can, therefore, be written as

$$Q_t = f_4\ (N_{t-1}, \Delta N, \Delta E, (w/w_o)_t, Wi_t, SL_{t-1}, t), \quad (28)$$

which seems consistent with theoretical models of quits, for instance, with Parsons' model [15], which is based on a search-theoretic framework. In contrast to some previous specifications of quit functions, for instance Hamermesh's [8], equation (28) does not contain the national unemployment rate. Both a priori considerations and experimentation with different variables suggested that ΔN, ΔE, and SL_{t-1} may be the best set of explanatory variables to represent job opportunities inside and outside the industry.

The other separations D consist of several components that may be influenced by different factors and, hence, it is rather difficult to model them satisfactorily. It would appear, however, that at least some of the arguments in the quit function should also play a role in the determination of other separations. Thus the variables that measure the relative attractiveness of jobs in the industry may influence retirements to the extent that they are not completely automatic. Further, the Wi variable may again be an adequate measure of the number of low-tenure employees, which must be an important determinant of the number of discharges for reasons such as incompetence or dishonesty. Finally, N_{t-1} should again be included as a scale variable that may influence D_t nonproportionately. Thus the last turnover function can be expressed formally as

$$D_t = f_5\ (N_{t-1}, \Delta N, \Delta E, (w/w_o)_t, Wi_t, SL_{t-1}, t). \quad (29)$$

Equations (19) to (29) describe two versions of the model of net and gross flows of labor that have been used in the empirical estimation in the attempt to obtain empirical measures of displacements and unreplaced attritions. In the first version of the model, equations (22) and (23) are omitted so that the employers' turnover variables are NH, RH, and L, whereas in the second version equations (19) to (21) are omitted so that the employers' turnover variables are DIS and ATT. The remainder of the model is identical in both versions. Further, for some purposes the model has to be supplemented by equation (10), which describes the movement of SL through time. In both versions of the *complete model*, the following variables are thus endogenous: ΔN and, hence, N_t, Q, D, and ΔSL and, hence, SL_t. In addition, NH, RH, and L are endogenous in the first and DIS and ATT in the second version of the model. Further, the following variables are *exogenous* in both versions of the complete model: OR, w, t, N_{t-1}, I_{t-1}, U_{t-1}, SL_{t-1}, w/w_o, ΔE, Wi, and δ.

Let us now turn to a description of the estimation of this model.

Table 2

The Net Employment Demand Equations

Independent Variables	Durables	Nondurables
OR	0.0262 (5.08)	0.0330 (4.26)
w	−29.085 (−0.07)	101.89 (0.64)
t	−10.043 (−2.28)	−12.418 (−4.77)
Q	0.6996 (2.39)	0.2480 (1.84)
D	1.3649 (1.28)	0.7459 (1.54)
SL	−0.0871 (−0.41)	0.2021 (0.76)
N_{t-1}	−0.7429 (−3.95)	−0.2181 (−2.02)
I_{t-1}	0.0193 (1.11)	−0.0244 (−1.31)
U_{t-1}	0.0124 (1.86)	−0.0074 (−0.21)
R^2	0.79	0.93
D-W	1.21	2.23

Note: The figures in parentheses are t-ratios. For sample periods, see Table 1. The column headed D-W contains the Durbin-Watson d-statistics.

C. The Empirical Results

The model that is summarized by equations (19) to (29) has been fitted to quarterly data for twenty-four manufacturing industries. Most of the data required for this purpose are readily available in *Employment and Earnings, Manufacturers' Sales, Inventories and Orders*, and the *Monthly Labor Review*. Some data had to be processed prior to fitting the model. The raw data have, however, not been seasonally adjusted and, hence, intercept dummies for the second, third, and fourth quarters have been included as independent variables. Typically these dummies take on the value 1 in their own quarter and 0 in others. In the equations for quits and other separations, however, the seasonal pattern was found to be slightly different and the dummies take on the value of N_{t-1} in their own quarter and 0 in all others.

In initial trials the net labor demand and labor turnover functions were approximated by both linear and log-linear forms. By and large, the linear versions of the model tended to give better results. The linear specification also has the advantage that the constraint given by $\Delta N = A - S$ can be checked or incorporated into the model quite easily.

Various alternative estimaton methods have been used, but the differences in the results do not seem to be substantial. For the results presented here, the net demand for labor, the quit, and the other separations functions have been estimated by ordinary least-squares and all the other labor turnover functions by two-stage least-squares for which ΔN is the jointly dependent variable.

For some equations the Durbin-Watson statistics are somewhat low. These equations were adjusted for autocorrelation and reestimated. Since, however, the regression coefficients did not change very much, only the results of the unadjusted equations are reported. Low Durbin-Watson statistics should thus be regarded as signals pointing to possible misspecifications.

For brevity the results for only two industrial categories, total durable and total nondurable goods industries, are presented but some of the other results are mentioned briefly. The evidence of Table 2 suggests that the net flow demand for labor is determined predominantly by real orders, the time trend, quits, and lagged employment. In durable goods industries unfilled orders also appear to exert a positive influence upon ΔN. The real wage and the stock of laid-off workers do not affect the net change in employment significantly.

Table 3 contains the empirical estimates of the parameters for the new hire, rehire, layoff, and displacement equations. In all of these equations, ΔN is treated as the jointly dependent variable, so that the values for $\Delta \hat{N}$ are those predicted by the instrumental variables that are the independent variables listed in Table 2. Let us discuss the parameters in Table 3 in some detail. New hires are affected positively and significantly by the net change in employment and quits and negatively by the stock of laid-off employees. Rehires are related positively to the stock of laid-off workers but not very strongly or consistently to any of the other variables. Layoffs respond negatively to net employment changes, quits, and other separations and positively to the stock of laid-off employees. As has already been pointed out, this positive association between L and SL must be attributed to a positive association between the error Z and SL. In other words, as the stock of laid-off employees rises, the error Z, which is defined by $\Delta N = A - L - Q - D + Z$, tends to rise and this rise is offset by an increase in L. This is an interesting association, which deserves further analysis and may yield a clue to the reason why Z occurs. Next let us consider displacements. Two series for displacement have been fitted. Series A is defined as $DISA = L - RH$ and series B as $DISB = L - RH - Z$.

Table 3

The New Hire, Rehire, Layoff, and Displacement Equations

Independent Variables	New Hires	Rehires	Layoffs	Displacements *A*	Displacements *B*
			Durables		
$\widehat{\Delta N}$	0.3984	−0.1101	−0.7310	−0.6210	−0.6016
	(8.95)	(−3.47)	(−13.94)	(−13.22)	(−13.51)
Q	0.9210	0.0786	0.0985	0.0200	−0.0790
	(8.93)	(1.07)	(0.81)	(0.18)	(−0.77)
D	−0.1192	0.1885	−0.7579	−0.9463	−1.1192
	(−0.42)	(0.95)	(−2.27)	(−3.17)	(−3.96)
SL	−0.2589	0.3085	0.1739	−0.1346	−0.2589
	(−5.52)	(9.23)	(3.15)	(−2.72)	(−5.52)
R^2	0.97	0.87	0.88	0.89	0.91
$D\text{-}W$	2.06	1.22	2.19	2.27	2.06
			Nondurables		
$\widehat{\Delta N}$	0.4037	0.0105	−0.5929	−0.6034	−0.5963
	(4.87)	(0.24)	(−10.49)	(−9.38)	(−7.19)
Q	0.8254	−0.0125	−0.1576	−0.1450	−0.1746
	(11.13)	(−0.32)	(−3.12)	(−2.52)	(−2.35)
D	0.2952	−0.1893	−0.4352	−0.2459	−0.7048
	(1.20)	(−1.45)	(−2.59)	(−1.29)	(−2.86)
SL	−0.1900	0.1855	0.1721	−0.0134	−0.1900
	(−1.69)	(3.10)	(2.24)	(−0.15)	(−1.69)
R^2	0.98	0.91	0.95	0.95	0.95
$D\text{-}W$	1.11	1.09	1.83	1.82	1.11

For notes, see Table 2.

Corresponding to these two series there are two series for unreplaced attritions; series A includes and series B excludes Z, or $ATTA = Q+D-NH-Z$ and $ATTB = Q+D-NH$. As a result of these definitions, the error Z is attributed to either DIS or ATT, so that the definitional identity between the net and gross flows of labor has been made to hold exactly in these data. In other words, $ATTA + DISA = -\Delta N$ and $ATTB + DISB = -\Delta N$ and either the A or the B specification can be used. The coefficients that relate $ATTA$ and $ATTB$ to $\Delta\hat{N}$, Q, D, and SL can be obtained easily from the coefficients of the displacement equations in Table 3. The $\Delta\hat{N}$ coefficients of the displacement and attrition equations must sum to −1 and the coefficients of Q, D, and SL have the same absolute value but opposite signs in the displacement and attrition equations.[14] As it happens, the $DISA$ and $DISB$ equations are quite similar, but the B specification, which assigns the error Z to displacements, seems slightly superior to the A specification. By and large, the results for the other twenty-two industries are similar to those presented in Table 3. In particular, new hires tend to be related positively and layoffs negatively to $\Delta\hat{N}$, Q, and D. Further, increases in SL tend to raise new hires and reduce rehires. But other aspects of the rehire equations are not entirely satisfactory.

Table 4 contains the final set of results, namely those for quits and other separations. Both quits and other separations are related positively to the level of employment N_{t-1} and the current and recent changes in employment ΔN and $W4$. Further the impact of relative wage w/w_o is negative but not significant. The time trend tends to have a positive influence on quits and a negative one on other separations. The stock of laid-off workers raises quits in durables and reduces them in nondurables, whereas the change in employment outside the industry ΔE reduces quits in durables and raises

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[14] Thus the coefficients of the $ATTA$ equation for total durables are −0.3790, −0.0200, 0.9463 and 0.1346 for $\Delta\hat{N}$, Q, D, and SL, respectively. It should be noted that $DISB$ can also be expressed as $DISB = -\Delta N+NH-Q-D$ and, hence, the coefficients of the NH and $DISB$ equations are related.

Table 4
The Quit and Other Separations Equations

Independent Variables	Durables		Nondurables	
	Quits	Other Separations	Quits	Other Separations
ΔN	0.2941 (6.63)	0.0486 (3.29)	0.0188 (0.19)	0.0287 (0.87)
N	0.2642 (10.75)	0.0578 (7.06)	0.3677 (5.56)	0.0688 (3.19)
t	−3.5610 (−5.30)	0.1607 (0.72)	−0.3372 (−0.44)	0.7831 (3.13)
SL	0.1537 (2.29)	0.0043 (0.19)	−0.1996 (−1.16)	0.0133 (0.24)
w/w_o	−506.09 (−0.68)	−334.18 (−1.34)	−922.21 (−0.68)	−508.03 (−1.15)
$W4$	0.0848 (3.75)	0.0044 (0.59)	0.1071 (2.09)	0.0152 (0.91)
ΔE	−0.1965 (−2.26)	−0.0240 (−0.83)	0.1092 (3.06)	−0.0029 (−0.25)
R^2	0.97	0.96	0.97	0.91
D-W	1.76	1.35	1.48	1.76

For notes, see Table 2.

them in nondurables. The results from the other twenty-two industries seem to contain very similar messages: ΔN, N_{t-1}, and $W4$ influence quits and other separations predominantly positively. But the strongest result is that for the relative wages w/w_o: In twenty of the remaining industries the coefficient of w/w_o is negative and in thirteen it is significantly so. This is an encouragingly strong result, especially in view of difficulties that are often encountered in attempts to discover the effects of relative prices in time series analyses.

It is not claimed that the empirical estimates presented in Tables 2 to 4 are entirely satisfactory. Several of the parameters have implausible signs and others are not significant. But this evidence does contain some substantive information on the interrelationships between net and gross flows of labor. These interrelations will be analyzed further in the next section.

D. The Simulation

The model summarized in equations (19) to (29) has several complex dynamic interdependencies and, hence, it is difficult to ascertain all its properties by analytical methods. An attempt has, therefore, been made to obtain the most important implications of the model by means of a simulation exercise. Let us describe this simulation in some detail by dealing, first, with the steady-state properties of the model and, second, with its short-run responses to exogenous shocks.

(1) For a discussion of the steady-state properties of the model, equations (19) to (29) have to be supplemented by equation (10), which describes the movement through time of the stock of laid-off employees. The steady state of the model is then said to exist when $\Delta N = N_t - N_{t-1} = 0$, $Wi = N_{t-1} - N_{t-1-i} = 0$, and $\Delta SL = SL_t - SL_{t-1} = 0$. In other words, with given exogenous variables, all endogenous variables are at their steady-state levels when *both* the stock of employment *and* the stock of laid-off employees are constant over time. When these steady-state conditions are assumed, the model, with the estimated parameters, can be solved for its endogenous variables on the basis of any arbitrary set of exogenous variables. For the initial computations, the exogenous variables OR, w, t, I_{t-1}, w/w_o, ΔE, and δ were assumed to be at their sample means. The resulting steady-state values of the endogenous variables are presented in Table 5, together with their sample means. For version 2 of the model the error Z has been attributed to displacements and therefore $DISB + ATTB = -\Delta N$.

Inspection of the figures in Table 5 suggests that the steady-state values of the endogenous variables are not vastly different from their sample means. This similarity is not necessarily implied by the structure of the model or the estimation techniques and, hence, it may be viewed as a satisfactory aspect of the model.

In order to be able to study the response of the model to an exogenous reduction in demand, the system was

Table 5
The Steady-State Values of the Endogenous Variables

	Durables			Nondurables		
		Steady-State Values			Steady-State Values	
	Sample Means	Version I	Version II	Sample Means	Version I	Version II
ΔN	16.695	0	0	11.642	0	0
N	10705.281	10719.087	10709.419	7749.955	7861.774	7757.818
SL	518.142	555.540	383.676	257.607	255.530	211.250
NH	868.019	848.157		761.760	787.815	
RH	400.792	413.798		316.676	313.976	
L	478.545	497.129		396.342	393.191	
Q	562.095	558.222	529.140	533.014	567.951	536.617
D	281.003	280.663	279.340	167.287	173.886	165.907
$DISB$	8.226		57.551	49.818		65.488
$ATTB$	−24.921		−57.551	−61.460		−65.488
$NH+RH-L-Q-D$	−52.832	−74.059		−18.207	−33.237	
$L-RH$	77.753	83.331		79.666	79.215	
$Q+D-NH$	−24.921	−9.272		−61.459	−45.978	
Z	69.527	74.059	0	29.849	33.237	0

Note: All numbers in thousands. For sample periods, see Table 1. Version I consists of equations (10), (19) to (21) and (24) to (29). Version II consists of equations (10), (22), (23) and (24) to (29). Z is defined as $Z = \Delta N - NH - RH + L + Q + D = \Delta N + ATT + DIS$.

started in the initial steady state and then subjected to an exogenous shock that took the form of a 10 percent reduction in real orders *OR*, real inventories *I*, and real unfilled orders *U*. But the other exogenous variables were all held at their sample means. This procedure may require some further explanation.[15] As has been mentioned in section B of this part of the paper, the model expressed in equations (19) to (29) should be supplemented by two additional dynamically interdependent functions; they determine the change in real inventories ΔI and in real unfilled orders ΔU. In a complete specification of the dynamic effects of changes in demand, firms should be allowed to respond to a ceteris paribus reduction in real orders *OR* by reducing gradually the stocks of equipment, real inventories, and real unfilled orders to their new steady-state levels. In the present simulation, by contrast, real inventories and unfilled orders are reduced to their new steady-state levels *instantaneously* and, moreover, these reductions are supposed to be proportionate to that in real orders. Thus, the simulation traces the short-run and long-run effects of a 10 percent reduction in real orders, real inventories, and real unfilled orders upon net employment and all the labor turnover categories. The reason for this simplified approach is that the primary purpose of the research underlying this paper has been to obtain the relationships between net changes in employment and the labor turnover flows. The estimates of these relationships may not be affected much by the above simplification, which seems to influence primarily the estimate of the net change in employment.

The long-run effects of a 10 percent reduction in *OR*, *I*, and *U* are presented in Table 6. This table contains the new steady-state levels of the endogenous variables for the two versions of the model and the two industry groups as well as the percentage differences between the initial and the new steady-state levels. Thus, the reductions in *OR*, *I*, and *U* cause reductions in the steady-state values of employment, new hires, quits, other separations, and unreplaced attritions and increases in those of the stock of laid-off employees, rehires, layoffs and displacements. The signs of the changes in the steady-state levels are the same for both industry groups though their magnitudes differ substantially in some instances. A particularly striking feature of these numbers is the large decline in quits, which is much larger proportionately than that in employment. Consequently, the quit *rate*, that is, the ratio of Q to N, is much lower in the depressed than in the prosperous steady state.

A comparison of the steady-state levels in Tables 5 and 6 suggests that, in relatively prosperous times, quits, other separations, and new hires tend to be high

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[15] If the reduction in an industry's output is due to a trade liberalization policy that involves international reciprocity, then the simulation exercise should be based on the assumption that some industries contract and others expand their employment levels. In the above simulation alternative industries remain unaffected and, hence, the present results may be too gloomy.

Table 6
The Second Steady-State Values

	Durables				Nondurables			
	Version I		Version II		Version I		Version II	
	New Level	Percent Difference*	New Level	Percent Difference	New Level	Percent Difference	New Level	Percent Difference
N	10004.447	−6.67	9995.944	−6.66	6721.538	−14.50	6618.925	−14.68
SL	683.323	23.00	532.159	38.70	537.127	110.20	493.418	133.57
NH	657.045	−22.53			301.416	−61.74		
RH	431.364	4.25			387.062	23.28		
L	533.863	7.39			553.571	40.79		
Q	381.189	−31.71	355.610	−32.79	71.139	−87.47	40.210	−92.51
D	238.496	−15.02	237.332	−15.04	96.575	−44.46	88.699	−46.54
DISB			79.824	38.70			152.960	133.57
ATTB			−79.824	−38.70			−152.960	−133.57
$NH+RH-L-Q-D$	−65.139	12.04			−32.807	1.29		
$L-RH$	102.499	23.00			166.509	110.20		
$Q+D-NH$	−37.360	−302.93			−133.702	−190.80		

For notes, see Table 5.
*The differences in the steady-state levels in Tables 5 and 6.

and to take care of a relatively large proportion of the reallocation of workers among establishments and industries. In relatively depressed times, on the other hand, quits, other separations, and new hires tend to be low and the function of the reallocation of workers seems to be shifted to layoffs, rehires, and the stock of laid-off employees, all of which are larger than in prosperous times.

(2) Although the long-run consequences of reductions in real orders, inventories, and unfilled orders may be of considerable interest, the primary focus of the research underlying the present paper is on the short-run adjustment paths of employment and the labor turnover flows. Figures 2 to 5 trace the paths of employment, the stock of laid-off employees, and the turnover variables that occur as a consequence of the 10 percent exogenous reduction in real orders, inventories, and unfilled orders. The figures refer to both versions of the model and both industry groups. The reader should note that the scales of Figures 2 to 5 are not all identical and that the origin of the stock of employment has been adjusted so as to make it fit into the diagrams with the other variables. The main implications of Figures 2 to 5 are as follows: all four versions of the model are stable in the sense that the variables approach their new steady-state levels and do not diverge from them. Further, in the durable goods industries, adjustment tends to be quite fast: all variables are quite close to their new steady states within one year after the disturbance. In the nondurable goods industries the adjustment is somewhat slower. Further, in nondurables the variables approach their new steady-state levels monotonically, whereas in durables they overshoot their steady-state levels and then return to them.

In order to obtain an impression of the roles played by the various labor turnover categories in a downward adjustment of employment, Table 7 has been prepared. It contains the cumulated deviations from the initial steady states of the various net and gross flows of labor. The period over which the observations have been cumulated is one calendar year, namely the four quarters that follow the exogenous demand reduction. Thus, the number in the first row and column in Table 7 indicates that, during the four quarters after the disturbance, employment has fallen by a total of 709,800 below its initial steady-state level and the other numbers in the first column should be interpreted similarly. To obtain an impression of the *relative* importance of the various labor turnover categories, the numbers are presented also as percentages of $-\Delta N$. The following characteristics of the evidence in Table 7 should be noted. In version 1 of the model new hires decline by more than the net reduction in employment in both industry groups. But this decline is offset by substantial reductions in quits and other separations, so that the estimated unreplaced attritions are only 15.6 percent of $-\Delta N$ in durables and −13.5 percent in nondurables. Layoffs rise substantially and are offset only partially by increases in rehires so that the estimated displacements are 57.2 and 69.5 percent of $-\Delta N$ for durables and nondurables, respectively. The error, that is the difference between ΔN and $(NH+RH-L-Q-D)$ is 27.2 percent for durables and 44 percent for nondura-

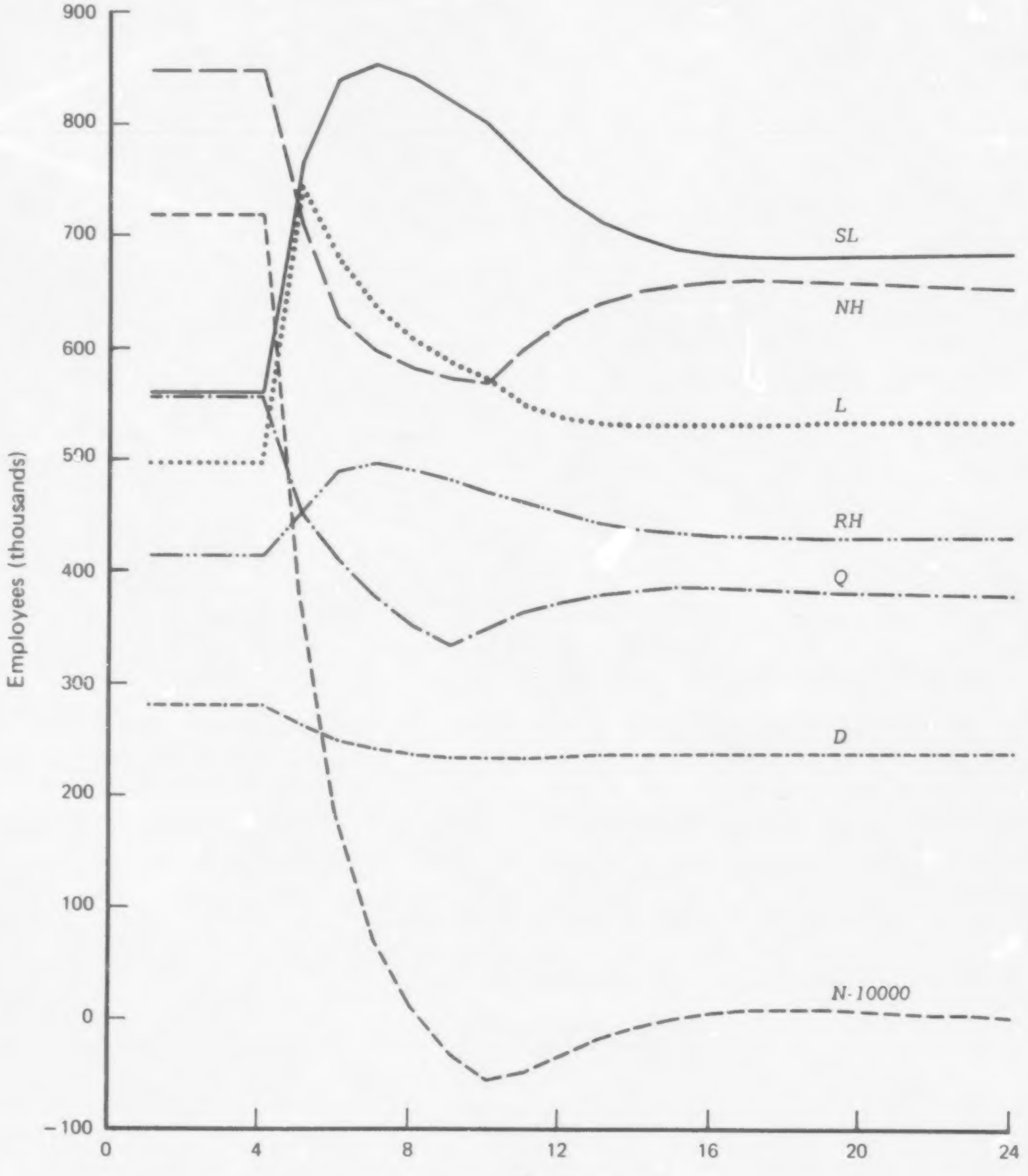

Figure 2
Durable Goods Industries, Version 1

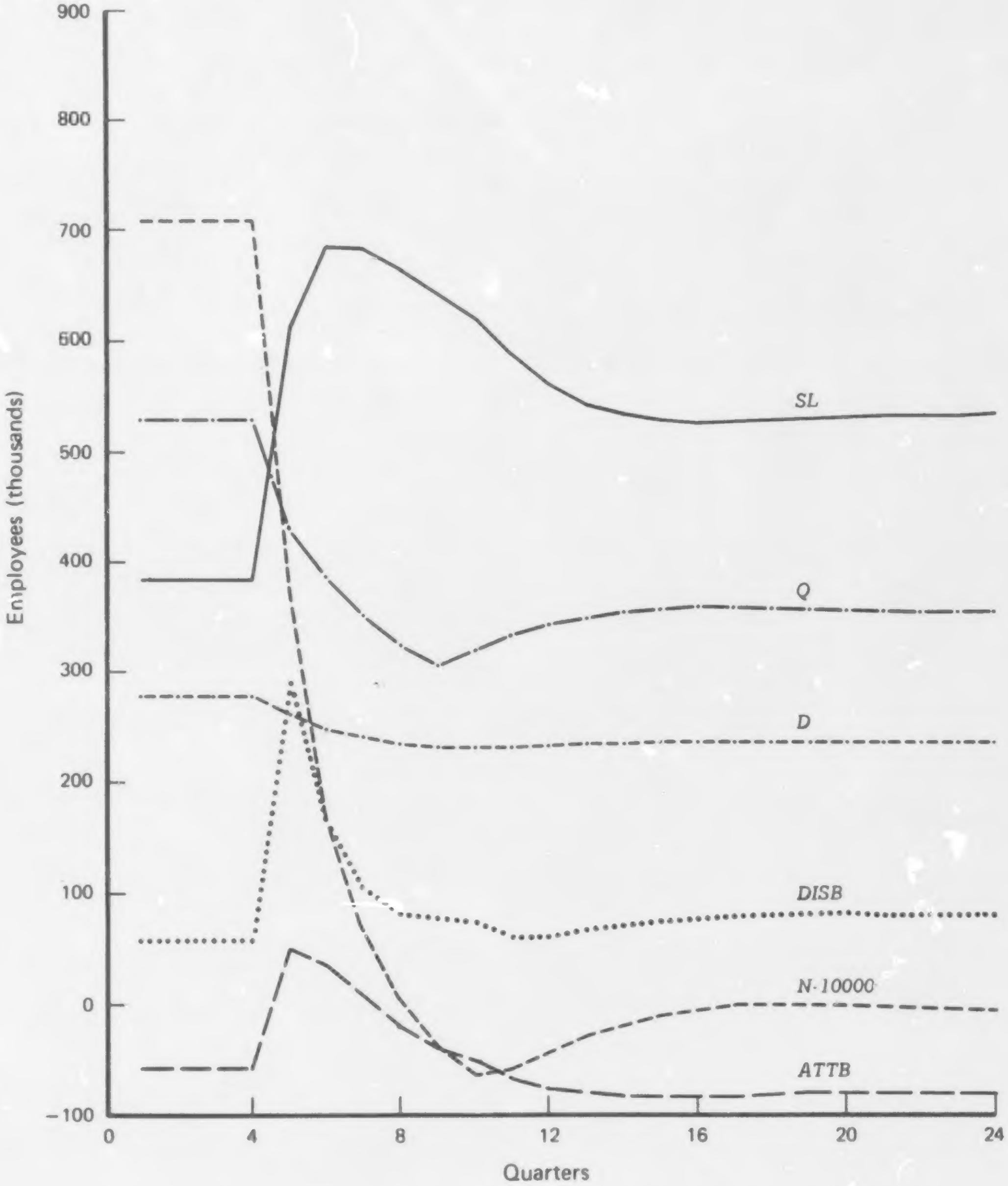

Figure 3
Durable Goods Industries, Version 2

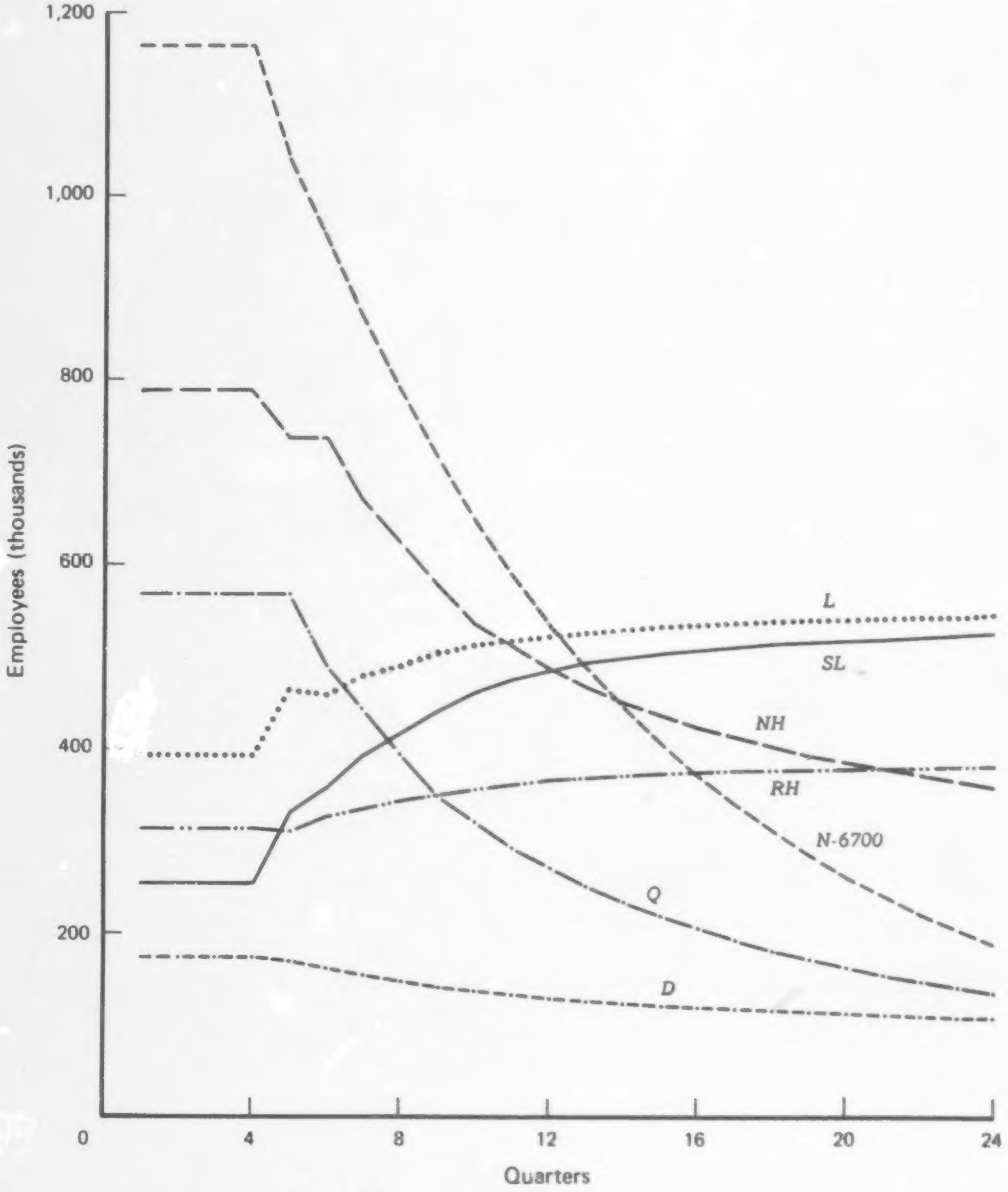

Figure 4
Nondurable Goods Industries, Version 1

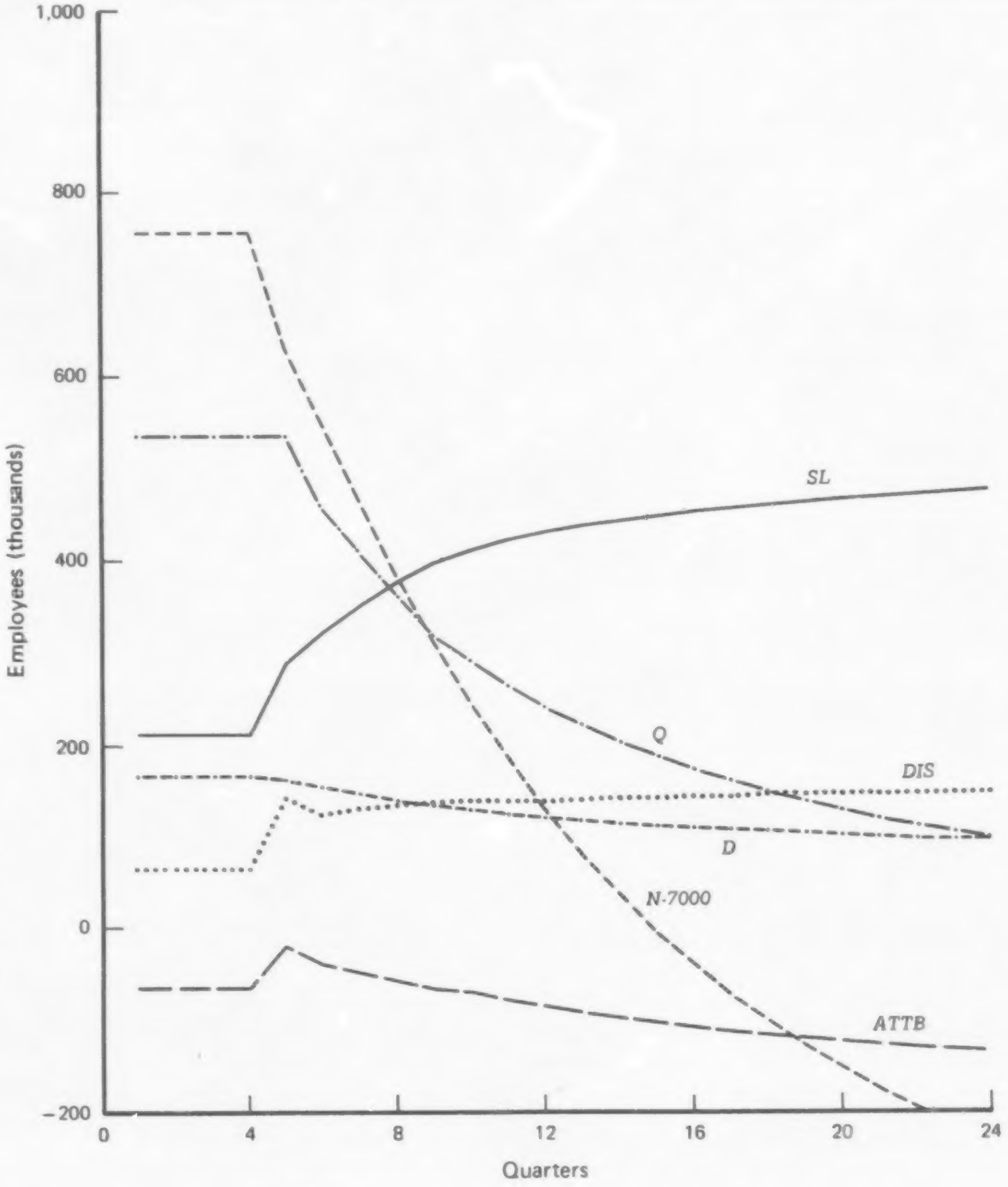

Figure 5
Nondurable Goods Industries, Version 2

Table 7

Cumulated Deviations from Initial Steady States

	Durables				Nondurables			
	Version I		Version II		Version I		Version II	
	Thousands	Percent of $-\Delta N$	Thousands	Percent of $-\Delta N$	Thousands	Percent of $-\Delta N$	Thousands	Percent of $-\Delta N$
ΔN	−709.8	100.0	−708.3	100.0	−374.6	100.0	−372.2	100.0
NH	−873.1	−123.0			−392.1	−104.7		
RH	273.8	38.6			63.8	17.0		
L	679.7	95.8			324.2	86.6		
Q	−633.6	−89.3	−628.3	−88.7	−381.7	−101.9	−383.6	−103.1
D	−128.7	−18.1	−128.5	−18.2	−61.1	−16.3	−60.6	−16.3
$L-RH$	405.9	57.2			260.4	69.5		
$Q+D-NH$	110.8	15.6			−50.7	−13.5		
$NH+RH-L-Q-D$	−516.7	−72.8			−209.7	−56.0		
$DISB$			404.4	57.1			268.7	72.2
$ATTB$			303.9	42.9			103.5	27.8

bles. In version 2 of the model this error must disappear. The differences between the estimates of ΔN, Q, and DIS for the two versions of the model are negligibly small. The only striking differences occur in the estimates of unreplaced attritions, which are substantially higher in version 2 than in version 1. Indeed, the entire error of version 1 seems to be attributed to $ATTB$ in version 2.

For present purposes, the most interesting implication of Table 7 is that, despite the very large decline in new hires, unreplaced attritions seem to play only a secondary role in bringing about net reductions in employment. The reason for this phenomenon is that new hires respond to a sharp fall in quits so that new hires and quits fall in a mutually offsetting manner. In section 3A, it has been pointed out that Hamermesh's approach implies that unreplaced attritions account for 79 percent of any net reduction in employment. As noted, this finding is based on the assumption that the industry's quit rate is independent of economic conditions within the industry. The finding of the present research is that such an assumption can substantially bias the results. The numbers in Table 7 suggest, by contrast to Hamermesh's, that the fall in quits may prevent unreplaced attritions from bringing about a large proportion of any net reduction in employment. According to these estimates unreplaced attritions amount to, at most, 42.9 percent of $-\Delta N$. Although no finality is claimed for the present results, they do suggest that quits ought to be allowed to respond to changes in economic conditions within the industry in future investigations of labor turnover, especially if they are aimed at obtaining estimates of unreplaced attritions and displacements.

4. Conclusions

In the research underlying this paper an attempt has been made to estimate the displacements and unreplaced attritions that must be expected to occur as a result of exogenous reductions in the demand for an industry's output. Such reductions may be caused by many factors, including trade liberalization measures and the ensuing increase in import penetration, the effects of which are of particular interest in the present context.

Parts 2 and 3 of this paper contain the general conceptual framework of the analysis, a description of the time series data, and the result of the construction, estimation, and simulation of the model. The main conclusion of the analysis is that unreplaced attritions may not be as important in bringing about net reductions in employment as is sometimes suggested. Although firms cut their new hires drastically when demand falls, this is largely caused and offset by substantial reductions in voluntary quits. In other words, since attritions fall with demand conditions, attempts by firms to effect net reductions in employment through unreplaced attritions tend to have only limited success and the primary method of reducing employment takes the form of displacements.

It seems that the time series data on labor turnover have not been analyzed previously with a view to obtaining estimates of displacements and unreplaced attritions. The estimates presented in this paper should, therefore, be regarded as a first attempt at generating quantitative information that has potentially important implications for economic policy. A number of obvious areas for further research suggest themselves. The conceptual framework might be changed. Following Mortensen [17] and Pencavel [12], it might be assumed that the typical firm controls its quits through its relative wages. The rehire equation, which currently yields unsatisfactory empirical results, should perhaps also be specified differently. For the empirical estimation, different functional forms and different econometric methods could be tried in an effort to improve the results. Finally, estimates of displacements and unreplaced attritions should be obtained for industries that are smaller than total durable and total nondurable goods industries. Disaggregation seems to be especially desirable, because at highly aggregated industry classifications much labor turnover is intra-industry turnover and, as has been pointed out in part 2 of this paper, such intra-industry turnover, to the extent that $NH_1 > 0$, tends to bias the estimates of displacements and unreplaced attritions. As discussed in part 3, the model has been fitted to twenty-two additional manufacturing industries and the results are being analyzed currently. As has been found by Nadiri and Rosen [13], however, the same model of factor demand does not perform equally well at all levels of aggregation and, hence, some industry-specific modeling may be necessary. It is hoped that future research will provide information on the reliability of the currently available estimates of displacements and unreplaced attritions as well as on the source of any intra-industry differences in the relative importance of displacements and unreplaced attritions as a means of reducing employment.

Literature Cited

1. Bale, Malcolm D. "Estimates of Trade-Displacement Costs for U.S. Workers." *Journal of International Economics*, 6 (August 1976), 245–50.
2. Barth, Peter S. "A Time Series Analysis of Layoff Rates." *The Journal of Human Resources*, 6 (Fall 1971), 448–65.
3. Brechling, Frank. "Hamermesh's Labor Turnover Model and Its Implications for Displacements and Attritions." Mimeographed. PRI Working Paper 76–306.
4. _____. *Investment and Employment Decisions*. Manchester: Manchester University Press, 1975.
5. Brechling, Frank, and Dale Mortensen. "Interrelated Factor Demand Functions." Mimeographed.
6. Burton, John F., and John E. Parker. "Interindustry Variations in Voluntary Labor Mobility." *Industrial and Labor Relations Review*, 22 (January 1969), 199–216.
7. Hall, Robert E. "Turnover in the Labor Force." *Brookings Papers on Economic Activity*, (3: 1972), 709–53.
8. Hamermesh, Daniel S. "A Disaggregative Econometric Model of Gross Changes in Employment." *Yale Economic Essays*, 9 (Fall 1969), 107–45.
9. Jacobson, Louis S. "Earnings Losses of Workers Displaced from Manufacturing Industries." This volume.
10. _____. "Estimating the Loss in Earnings for Displaced Workers in the Steel Industry." In *Removing Restrictions on Imports of Steel*, PRI 75–2, Center for Naval Analyses.
11. Mattila, J. Peter. "Quit Behavior in the Labor Market." *Proceedings of the Business and Economic Statistics Section*, American Statistical Association, 1969, 697–701.
12. Mortensen, Dale T. "A Theory of Wage and Employment Dynamics." In *Microeconomic Foundations of Employment and Inflation*, edited by Edmund S. Phelps et al. New York: W. W. Norton, 1970.
13. Nadiri, M. Ishaq, and Sherwin Rosen. *A Disequilibrium Model of Demand for Factors of Production*. New York: National Bureau of Economic Research, 1974.
14. Parsons, Donald O. "Quit Rates over Time: A Search and Information Approach." *American Economic Review*, 63 (June 1973), 390–401.
15. _____. "Specific Human Capital: An Application to Quit and Layoff Rates." *Journal of Political Economy*, 80 (November/December 1972), 1120–43.
16. Parsons, Donald O., and Belton Fleisher. "Layoffs and Experienced Worker Unemployment Behavior." Mimeographed.
17. Pencavel, John H. *An Analysis of the Quit Rate in American Manufacturing Industry*. Princeton: Industrial Relations Section, Princeton University, 1970.
18. _____. "Wages, Specific Training and Labor Turnover in U.S. Manufacturing Industries." *International Economic Review*, 13 (February 1972), 53–64.
19. Stoikov, Vladimir, and Robert R. Raimon. "Determinants of the Differences in the Quit Rate among Industries." *American Economic Review*, 58 (December 1968), 1283–98.
20. Toikka, Richard S. "A Markovian Model of Labor Market Decisions by Workers." *American Economic Review*, 66 (December 1976), 821–34.

Earnings Losses of Workers Displaced from Manufacturing Industries

Louis S. Jacobson*

Introduction

A particularly sensitive current policy issue is the effect of changes in tariffs and quotas on employment and earnings. This study examines empirically some of the effects of a permanent labor displacement that might result from changes in international trade policy. Specifically, this paper presents estimates of how job displacement would change the long-term earnings of workers in eleven industries, and relates the findings to industry characteristics so that they can be projected to industries not directly studied. The study described here was designed to assist in determining industries in which trade liberalization would impose large losses on workers.

The results show that average prime age male workers suffer substantial losses of earnings in industries where the normal rate of labor turnover is low and prime age males make up a high percentage of the total labor force. These industries also tend to be high-wage industries.

Displacement from the auto and steel industries is estimated to reduce earnings over a six-year period by about 24 percent, and by almost as much in several other high-wage industries. The estimated loss in low-wage industries was very much smaller, averaging about 5 percent. In some cases, such as cotton weaving, no appreciable loss could be detected.

The methodology and data used in the study were applied earlier in measuring how the earnings of steel workers would change if they lost their jobs due to import competition [3]. That study used data drawn from the Social Security system's Longitudinal Employee-Employer Data (LEED) file to examine both earnings losses per worker and the number and characteristics of workers displaced under a range of circumstances, for groups of workers who differ by race, age, and prior work history. We found that the earnings losses for most groups of steel workers would be quite large, totaling as much as $17,000 over a given worker's lifetime. We found that, although any worker losing his job would pay a high price, comparatively few workers would be placed in this position as a result of trade liberalization.

This study extends our earlier work to other industries, providing estimates of how much the earnings of displaced workers would be reduced.[1] The basic procedure used was to measure the earnings of workers after they permanently left an industry during an employment reduction. These earnings were then compared to the earnings of similar workers who were not displaced during the employment cutback.

Although we are interested in losses resulting from an employment reduction induced by trade liberalization, the employment reductions we examined were due, in most cases, to other causes. The size of the loss depends on the value of human capital lost and on the costs of searching for a new job, but not on the reason an employment reduction is made. The findings are thus relevant for considering how reduced labor demand affects a worker's earnings, whether the reduced demand is due to import penetration or to other factors such as changes in technology or government regulations such as pollution control.

Definitions

In the following discussion a number of terms with precise meanings are used repeatedly. The objective of the study is to measure the effects of reductions in labor demand on the earnings of workers in industries likely to be affected by increasing import penetration. *Earnings loss* is the difference between what a worker actually earns after demand has fallen and what he would have earned had demand not fallen at that time.

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*This paper is based on Louis S. Jacobson "Earnings Losses of Workers Displaced from Manufacturing Industries," ILAB 74-25 which was completed in 1976.

[1] The steel study was more complete in examining earnings losses. That study measured how losses were affected by workers' age and tenure, and by economic conditions in the workers' local labor market. It also handled the basic data somewhat differently. Workers were grouped based on changes in steel employment by plant rather than by Standard Metropolitan Statistical Area (SMSA) and separations in different years were examined. Nevertheless, the results from the steel industry when redone using the methodology described in this paper were strikingly similar; thus, enhancing our confidence in the results presented here.

To measure earnings losses, we compare the earnings of workers who are adversely affected to the earnings of workers who are not affected. We make a basic distinction between workers who permanently leave an industry in a year when labor demand is falling and those who do not leave in that year. Workers who leave are called *leavers*; those who do not leave are called *stayers*.

Some leavers would have left because of illness, discharge for cause, or to search for a better job, even if there had been no employment reductions. Such leavers are called *attritions*. Workers who leave an industry permanently and would not have done so in the absence of reductions in labor demand will be called *displaced* workers.[2] These displaced workers are the principal focus of the study.

To measure the earnings losses of displaced workers, we should compare their postdisplacement earnings to the earnings of similar workers who were not displaced. The data did not allow us to distinguish which were attritions, however. Instead, losses of displaced workers were estimated by measuring how earning changes differed in groups of leavers that contained different proportions of displacements and attritions.

We were able to identify two groups of workers who permanently left each industry. One group included most of those displaced but also included some attritions. The other comprised mostly attritions but included some displaced workers as well.

By assuming that otherwise similar attritions in both groups had the same earnings, and that otherwise similar displaced workers in both groups had the same earnings, and by estimating the probability that a worker would be classified as an attrition, we could then subtract the effect of attrition on the earnings of the group containing most of the displaced workers; the remainder would then be a measure of the earnings loss due to displacement alone.

The two groups were identified by dividing workers in each industry on the basis of whether employment in the industry in the worker's SMSA was rising or falling in the year of separation. An SMSA with rising industry employment will be called a *rising SMSA*. An SMSA with falling industry employment will be called a *falling SMSA*. Thus, the group of leavers in SMSAs where employment was increasing (*rise-leavers*) were less likely to be displaced workers than the group of leavers in SMSAs where in the aggregate firms are reducing employment (*fall-leavers*).

The measured loss in earnings for fall-leavers proved to be a reasonably accurate estimate of the loss due to displacement alone. Losses estimated by subtracting the effect of attrition from the weighted average of losses did not add much useful information because they were subject to a very large measurement error. They did, however, suggest that using the loss estimates for the group with comparatively more displacements, without correcting for the inclusion of attritions, tended to underestimate slightly the loss due to displacements alone in high wage industries, to overestimate the loss in lower wage industries, and to estimate accurately the loss in industries in the middle of the earnings distribution.

The following discussion will describe in greater detail how these results were obtained. This will be followed by a discussion of possible underlying determinants of these results.

Measuring Earnings Losses

In order to measure what the earnings of workers who recently separated from a given industry would have been had they not left, a comparison group of stayers in the same industry is statistically matched to the leavers so that earnings potential is distributed identically between the two groups. Then the earnings of these two groups are compared over time.

Although many previous studies have examined the earnings losses of workers, few, if any, use a comparison group [2]. Mostly, the measures of earnings losses are based on before-and-after comparisons among those losing their jobs. This procedure may be acceptable in industries where age-earnings profiles are flat and specific human capital is not important, but it can lead to very misleading results. In the industries studied here, a before-and-after comparison among leavers would underestimate the total loss, since earnings of very few of these workers are reduced below preseparation earnings for more than a year or two.

Also, because a before-and-after comparison generally shows only a short-lived effect, it is not possible to estimate the permanence of the loss and the nature of the recovery process.

The methodology for measuring the loss econometrically was derived from our previous work on the steel industry and recent attempts to measure the impact of manpower training on earnings. The anlysis is based on a simple autoregressive model of earnings determination, sometimes called an earnings generating function. Equation (1) shows one specification for this function designed to be applied separately for different race-sex groups.

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[2] The displacement and attrition concepts used in this paper are not analogous to the more usual BLS turnover concept of layoffs and quits. As measured by BLS, all but about 15 percent of layoffs do not lead to a permanent separation. We cannot even consider all permanent layoffs as displacements, since some of these workers would have left anyway and should be considered attritions. Similarly, quits measured by BLS exclude workers who leave due to accident, illness, or discharge. This probably accounts for at least one-third of attritions.

$$Y_t = a_t + \sum_{i=1}^{k} b_{it} Y_{t-1} + c_t D, \qquad t=0, 1, \ldots, 5, \qquad (1)$$

where Y_t is earnings in year t, and D is a dummy variable equal to one if an individual was displaced in year 0, equal to zero otherwise.

Figure 1 illustrates the comparison being made using the autoregressive earnings function. The solid line represents the actual earnings of workers displaced in year zero. The dashed line represents the earnings of workers whose prior earnings patterns were identical but who were not displaced in year zero. The vertical difference between the two lines represents the earnings loss due to displacement.

The two curves also illustrate how a loss measure based on a before-and-after comparison can lead to systematic underestimates of the actual loss. The aggregate loss, measured relative to a comparison group, is equal to the area between the two curves. The earnings loss based on a before-and-after comparison is only the area bounded by a horizontal line drawn through the earning level just before the start of year zero and the line describing the actual earnings of displaced workers.

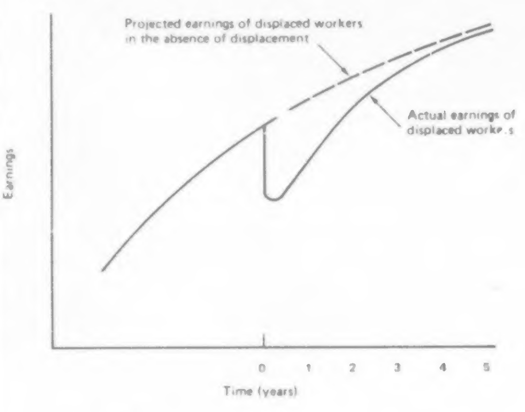

Figure 1
Comparison of Earnings of Displaced Workers and Workers Not Displaced

Although studies of manpower training frequently recognize the importance of using an appropriate comparison group in measuring earnings differences, this particular formulation has only been developed recently for use with Social Security earnings data similar to the Social Security data used here. It is more common to use variables such as age, education, occupation, and marital status to control for differences in earnings potential. Sherwin Rosen and others have argued, however, that "previous earnings patterns must be among the most powerful controls for reckoning earnings capacity, being the end result of the (human capital) accumulation process itself" [4, p. 37]. Orley Ashenfelter has shown, in a recent paper [1], that the functional form is fully consistent with what is known about the shape of the age-income profile and that under reasonable assumptions, the formulation is also consistent with a Becker-Mincer type model of optimal human capital accumulation.

Most importantly, this approach produces what are generally regarded as the most accurate estimates of the impact of manpower training available to date. In particular, by comparing earnings trajectories *prior* to entering a manpower training program, Ashenfelter demonstrates that this methodology is accurate in statistically matching a trainee and comparison groups in the pretraining period, even though the samples are drawn from very different populations. His comparison group included a random sample of all workers covered by Social Security.

In this work, the comparison group for workers displaced from a given industry is selected from other workers in the same industry. Additional information about the age and job tenure of workers is used to control for differences between the groups of separatees and comparison groups of stayers. The estimated earnings differences should, therefore, be considerably more accurate.

Modification of the basic autoregressive earnings function (equation (1)) is required because, as discussed earlier, there is no simple way of determining whether a worker who separates from an industry is displaced or leaves due to normal attrition. Even if it was known which workers were laid off, it would not be correct to assume that all such workers were displaced. Many workers with a high probability of being laid off would have left anyway in the absence of layoff.

For instance, recently hired young workers are very likely to change jobs in any event. These workers, however, are precisely those most likely to be laid off when employment must be reduced.

Because subsequent earning trends of displaced workers may be considerably different from the earning trends of workers leaving due to attrition, it is essential to determine how our results are affected by this potentially complicating factor.

To identify losses due to displacement from a given industry, the sample of workers employed in the industry in year zero was divided on the basis of whether employment in the worker's industry was rising or falling in the worker's SMSA in the year of separation. This produced four groups:

Fall-Leavers: those who separated from the industry in a year when industry employment in the SMSA was falling

Rise-Leavers: those who separated in a year when industry employment in the SMSA was rising or unchanged

Fall-Stayers: those who remained in the industry when industry employment in the SMSA was falling

Rise-Stayers: those who remained in the industry when industry employment in the SMSA was rising or unchanged.

The earnings of fall-leavers and rise-leavers following separation represent different combinations of the earnings of workers who left due to both attrition and displacement, as shown in Figure 2. Equations (2a) and (2b) show the distinction more explicitly:

$$Y_{FL} = \alpha Y_A + (1-\alpha)Y_D, \tag{2a}$$

$$Y_{RL} = \beta Y_A + (1-\beta)Y_D, \tag{2b}$$

where

Y_{FL} = average annual earnings of fall-leavers in any year following separation

Y_{RL} = average annual earnings of rise-leavers in any year following separation

Y_A = average annual earnings of workers leaving due to attrition in any year following separation

Y_D = average annual earnings of workers displaced in any year following separation

α = proportion of fall-leavers leaving due to attrition

β = proportion of rise-leavers leaving due to attrition.

We now make two crucial assumptions. First, we assume that, holding personal characteristics and workers' histories constant, a worker leaving a particular industry due to attrition will have the same earnings, irrespective of whether industry employment is rising or falling in the SMSA. Second, we assume the same condition holds for all displacement. Thus, as shown in equation (3), equations (2a) and (2b) can be solved simultaneously for Y_D in terms of α, β, Y_{FL}, and Y_{RL}.

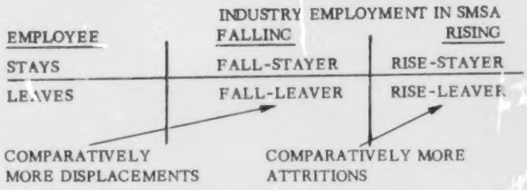
INDUSTRY EMPLOYMENT IN SMSA
EMPLOYEE
FALLING
RISING
STAYS
FALL-STAYER
RISE-STAYER
LEAVES
FALL-LEAVER
RISE-LEAVER
COMPARATIVELY MORE DISPLACEMENTS
COMPARATIVELY MORE ATTRITIONS

Figure 2
Classification of Workers in an Industry

$$Y_D = [\beta/(\beta-\alpha)]\ Y_{FL} - [\alpha/(\beta-\alpha)]\ Y_{RL}. \tag{3}$$

Since Y_{FL} and Y_{RL} are observable, we need to estimate only α and β to determine the earnings of displaced workers. To do this, we make the assumption that, controlling for worker characteristics, the probability of leaving due to attrition is independent of whether employment in a particular industry is rising or falling in an SMSA.[3] The observed number of workers leaving an industry in rising SMSAs divided by the total number employed in the industry in rising SMSAs (N_{RL}/N_R) is a good measure of the probability of leaving. This fraction times β is an estimate of the probability of leaving due to attrition in both rising and falling SMSAs. α is the proportion of fall-leavers separating due to attrition. It equals by definition the probability of leaving due to attrition times the number of risers divided by the number of fall-leavers. This relation is shown in equation (4).

$$\alpha = \beta \cdot \gamma, \tag{4}$$

where

$$\gamma = \frac{N_{RL}}{N_R} \cdot \frac{N_F}{N_{FL}}.$$

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[3] This assumption is probably an oversimplification. To some extent, the age and tenure specific attrition probabilities will be affected by changes in the probability of finding a better job which will, in turn, be associated with cyclical swings. The effect may not be important here because the observations are cross-sectional and the relative returns from job change may not vary much across SMSAs. In addition, there may be a systematic relation between changes in employment in an individual industry in an SMSA and changes in general business activity in the SMSA. This would tend to equalize relative returns of leaving a specific industry in falling and rising SMSAs. There is little empirical evidence bearing on the accuracy of the assumption. In particular, the cyclical sensitivity of the BLS quit rate may be due to changes in the age and tenure distribution of those employed rather than changes in the age and tenure specific quit propensities.

Substituting equation (4) into equation (3) produces an expression for the earnings of displaced workers Y_D, in terms of Y_{FL}, Y_{RL}, and γ, all of which can be estimated empirically. This expression is shown in equation (5).

$$Y_D = \frac{1}{1-\gamma} Y_{FL} - \frac{\gamma}{1-\gamma} Y_{RL}. \tag{5}$$

Finally, we can transform equation (5), expressing Y_D as a function of Y_{FL} alone plus an *adjustment factor*. This is done by subtracting $[\gamma/(1-\gamma)]Y_{FL}$ from the first right-hand term and adding it to the second right-hand term of equation (5). The transformed equation is shown in equation (6).

$$Y_D = Y_{FL} + \frac{\gamma}{1-\gamma} (Y_{FL} - Y_{RL}). \tag{6}$$

The earnings of fall-leavers would provide an adequate point estimate of the earnings of displaced workers if either γ were very small or the difference in the earnings of fall-leavers and rise-leavers were small. In both instances the adjustment factor shown in equation (6) would be extremely small.

Measuring the *earnings* of displaced workers is an intermediate step. What we want to measure ultimately is the earnings *loss* of displaced workers. To do this we must subtract the earnings of a comparison group of workers not displaced from the earnings of displaced workers.

Either fall-stayers or rise-stayers could have been used as a comparison group. It turned out that the earnings of workers in both groups were very similar; the earnings of fall-stayers were slightly below those of rise-stayers in the year separation occurred. Probably this is because fall-stayers are more likely to be on short hours or temporarily laid off in that year. Fall-stayers were chosen as the comparison group based on the supposition that displacements due to trade liberalization are likely to be large only when an industry is depressed anyway. The stayers in a trade impacted industry would therefore probably be more like the fall-stayers than the rise-stayers.

To calculate the losses L_D of displaced workers, the earnings of fall-stayers were subtracted from both sides of equation (6). This produced equation (7):

$$L_D = L_{FL} + \frac{\gamma}{1-\gamma} (L_{FL} - L_{RL}), \tag{7}$$

where

$$L_i = -(Y_i - Y_{FS}), \qquad i = D, FL, RL.$$

Equation (8) was used in the econometric estimation of earnings losses.[4]

$$\begin{aligned} \mathit{Earnings\text{-}t} = {} & a_0 + a_1\,\mathit{Earnings\text{-}M}_1 + a_2\,\mathit{Earnings\text{-}M}_2 \\ & + a_3\,\mathit{Earnings\text{-}M3} + a_4\,\mathit{Age} + a_5\,\mathit{Tenure} \\ & + a_6\,\mathit{Race} + b_1\,Y63 + b_2\,Y64 + b_3\,Y65 \\ & + c_1\,\mathit{Fall\text{-}Leave} + c_2\,\mathit{Rise\text{-}Leave} + c_3 \\ & \mathit{Fall\text{-}Stay} + (d_1\,\mathit{Qsep}2 + d_2\,\mathit{Qsep}3 \\ & + d_3\,\mathit{Qsep}4) \qquad\qquad (8) \\ & \quad t=0, 1, \ldots, 5, \end{aligned}$$

where

Earnings-i = Average quarterly earnings in year *i* (year *i* = 0 is year some workers left; year *i* = *M*1 is one year before displacement)

Age = Age in years as of year = 0

Tenure = Tenure since 1957 in quarters as of year = 0

Race = Race dummy: 0 = white; 1 = nonwhite

Y_i = Dummy variables for actual year some workers left (Samples for four years are pooled. *Y*62 is omitted.)

Fall-Stay, *Rise-Leave*, *Fall-Leave* = Dummies for four subsamples—workers either leave in year = 0 or stay in year = 0, and are either employed in SMSAs where industry employment fell or did not fall in year = 0 (*Rise-Stay* is omitted).

Qsepi = Quarter of separation in year = 0, dummies. (*Qsep*1 is omitted.) (These variables are enclosed in parentheses because regressions were run both with and without these variables.)

The first four terms in the equation incorporate the autoregressive earnings-generating function shown in equation (1). These variables, together with age and tenure, control for differences in human capital. The race variable is included to take into account the possibility that the earnings-generating function is different for blacks and whites. In part, this difference may be a result of discrimination.

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[4] A slightly different estimating equation was also used. This equation crossed age and tenure dummies with the fall-rise, stay-leave dummies in order to measure how earnings losses differed by age and tenure as well as by industry. The small sample size of many age-tenure groups, however, made accurate measurement difficult. The primary value of these regressions was that they showed that differences in the average losses across industries were not due to differences in the age and tenure distribution of the industries' work forces.

The year dummies are required because leavers and stayers in four separate years, 1962–65, were pooled in the regression to increase the sample size and thereby improve the statistical accuracy of the results. There was considerable variation over time in industry employment within each SMSA. That is, a falling SMSA in one year had an equal probability of being a rising SMSA the next. This limited the possibility that SMSA-specific characteristics rather than differences due to attrition and displacement were responsible for differences in earnings of fall-leavers and rise leavers.

The 1962–65 period was chosen because a substantial period was needed in order to trace the earnings pattern following displacement. The year dummies thus control for systematic differences in earnings during 1962–65 due to changes either in productivity or the inflation rate over time. The quarter-of-separation dummies adjust the losses to reflect separation at the beginning of a calendar year. This is particularly important in the year of separation.

The c_1, c_2, and c_3 coefficients measure the earnings difference between fall-leavers, rise-leavers, and fall-stayers, respectively, and rise-stayers (Y_i-Y_{RS}). Equation (7) can be expressed in terms of these coefficients as shown in equation (9).

$$L_D = -[c_1 - c_3 + \frac{\gamma}{1-\gamma}(c_1 - c_2)]. \tag{9}$$

Industry and Worker Selection

The methodology described in the previous section was used to estimate the earnings losses of displaced workers shown in Figure 1. The industries are listed in order by average earnings of workers before leaving. They were chosen to represent a diverse group of manufacturing industries. The wide range for each industry characteristic included in Table 1 indicates that this effort was reasonably successful. Selection also required that the industries have: (a) a wide geographic distribution to improve the dispersion of employment changes across local labor markets and thus increase the accuracy of the fall-rise breakdown; (b) large declines in employment, to produce as large a sample of fall-leavers as possible; and (c) substantial import competition.

The size of the average loss was estimated for each of six years following displacement using equation (8) for all workers meeting the criteria shown in Table 2. The first criterion limits the sample to workers who were permanently attached to the industry before they were displaced. The second criterion insures that each worker can be classified as a riser or faller. The third criterion, including work histories of prime-age males only, is designed to limit the study to workers least likely to withdraw from the labor force. Labor force withdrawal creates the very difficult problem of evaluating the monetary value of nonmarket time. The fourth criterion is related to the third: Once the group studied is limited to workers unlikely to withdraw from the labor force, a year or more of no reported earnings most

Table 1

Worker Characteristics by Industry

Industries Studied	Average Earnings of Prime-Age Male Leavers (in 1964 dollars)	Prime Age (23–53) Males as a Percent of Total Employment	Prime-Age Male Attrition
1. Petroleum refining	$7,677	66	1.8
2. Aerospace	7,132	68	4.2
3. Electronic components	6,338	33	4.5
4. Television receivers	5,874	36	10.6
5. Steel	5,712	72	1.9
6. Automobiles	5,688	71	1.6
7. Meat packing	5,320	64	1.5
8. Toys	4,670	34	11.9
9. Women's clothing	4,670	10	5.8
10. Shoes	3,824	26	9.6
11. Cotton weaving	3,705	38	8.0

Table 2
Selection Criteria

1. Employed at least three consecutive quarters in the designated industry and employed at least one quarter during the period 1962–65.
2. Employed in one of 229 SMSAs defined in 1967.
3. Males, age 23–53, in above year.
4. Reported earnings each year 1960–70.

probably is associated with work in uncovered employment, which is primarily self-employment, agricultural, and government work, incapacitation due to accident or illness, or a reporting error of some type. If workers in these categories were included in the sample, it would lead to serious overestimation of the earnings loss. The fact that some displaced workers who were included in the sample may work part-time in covered employment but full-time in uncovered employment means the losses may still be slightly overestimated.

Table 3 shows the size of the samples for each of the four subgroups in each industry, based on the criteria discussed in Table 2, and the estimated value of γ based on equation (6). We will call γ the probability of leaving the industry, in a falling SMSA, due to attrition. This is strictly true only if $\beta = 1$.

In all cases, the sample size of the stayer groups is large enough to ensure an accurate measure of their earnings, which is assumed to represent what leavers would have earned had they stayed. Among leavers, however, there are several cases where the samples are fairly small and estimation of losses probably is less precise. It is somewhat surprising that the number of fall-leavers is not greater, particularly because a major criterion for including an industry in the study was that it had experienced substantial employment reductions. Even in shoe manufacturing, which is generally regarded as a prime example of a declining industry, only slightly more than 50 percent of the workers were in SMSAs with employment declines.

It also appears that in some cases, such as toy manufacturing and cotton weaving, the reductions themselves are not severe in a single labor market but are widely dispersed. For these industries, the separation rate is only about 15 percent higher in SMSAs where industry employment fell than where it rose.

The results for the steel industry appear atypical. The proportion of workers in SMSAs with falling employment is higher than for other industries and the rate of leaving falling SMSAs lower. On close inspection it was discovered that the unusually heavy concentration of steel workers in Pittsburgh SMSA (one-third of all steel workers), coupled with the fact that employment in Pittsburgh fell by very small amounts in three of the four years, was responsible for these results. For instance, the employment reduction in 1962 was only about ½ of a percentage point. This raised the total number of workers in falling SMSAs and made the separation rate for fall-leavers appear unusually low.

The small observed employment reduction resulted from aggregating across the steel plants in Pittsburgh, some of which were increasing employment while others were decreasing employment. Fortunately, our previous work on the steel industry permitted us to disaggregate employment within SMSAs. The disaggregated data was used to estimate the value of γ for the steel industry shown in Table 3.

Estimated Earnings Losses

Table 4 shows the annual earnings loss, averaged over the first six years following displacement, for fall-leavers compared to fall-stayers and rise-leavers compared to fall-stayers. The cases where the loss is an earnings reduction is indicated by an unsigned number. Negatives denote the few cases where the "loss" is actually an earnings increase. The standard error of the estimates over the six years is shown in parentheses.

The losses of the fall-leavers are substantial and significantly different from zero in five of the eleven industries — oil, aerospace, steel, auto, and meat. As shown in Table 1, these industries are among the higher-wage industries and employ the highest percentages of prime-age males.

In industries where rise-leavers suffer large losses, fall-leavers also tend to have large losses, and vice versa. The losses are substantial and statistically significant in four industries. The only industry where fall-leavers show a statistically significant loss, but rise-leavers do not, is oil. This is probably due to the very small sample of rise-leavers in the oil industry.

The fact that rise-leavers show losses in all but one industry is worth comment. It is likely that these workers are almost all attritions. Although attritions include some workers who quit to take a better job, the evidence suggests that this type of attrition is relatively rare and the predominant reason for leaving in the absence of a firm's desire to lower employment is a mismatch between a worker's tastes and abilities and what employees require to perform a job. This explanation is also supported by the finding that rise-

Table 3

Sample Size for the Four Subgroups in Each Industry and Estimated Probability of Leaving Due to Attrition

	Oil	Aerospace	Electronics	TV Receivers	Steel	Auto	Meat	Toys	Women's Clothing	Shoes	Cotton
1. *Rise-Stayers (RS)*	553	10,204	1094	573	5280	4068	2628	275	376	359	428
2. *Fall-Stayers (FS)*	1693	5,306	632	131	5673	678	1104	229	568	387	338
3. *Rise-Leavers (RL)*											
a. number	10	451	51	68	105	66	41	38	23	38	37
b. % $RL=RL/(RL+RS)$	1.8	4.2	4.5	10.6	1.9	1.6	1.5	11.9	5.8	9.6	8.0
4. *Fall-Leavers (FL)*											
a. number	77	394	49	28	103	68	111	37	45	56	46
b. % $FL=FL/(FL+FS)$	4.4	6.9	7.2	17.6	1.8	9.1	9.1	13.9	7.3	12.6	9.4
5. Estimated probability of leaving a falling SMSA due to attrition (γ)	0.41	0.61	0.63	0.60	0.45*	0.18	0.16	0.86	0.79	0.76	0.85

*The estimate of γ for the steel industry was derived from more highly disaggregated data than used to designate falling and rising SMSAs.

leavers show larger losses than fall-leavers in eight of the eleven industries. Thus, workers who leave due to attrition are estimated to have *larger* losses than displaced workers.[5]

This evidence is consistent with the hypothesis that the quality (amount of human capital) of displaced workers is higher than the quality of those leaving due to attrition. If this is true, potential employers may usefully screen job applicants on the basis of a previous history of strong job attachment and may reasonably prefer to hire workers who had been laid off rather than those who quit. This appears to be particularly true in low-wage industries where minimal skills are required.

Losses Due to Displacement

We are finally in a position to calculate the loss due to displacement. As shown in equation (5), the loss is the sum of two terms. The first term is the estimated loss of fall-leavers and the second term, which we called an adjustment factor, is the product of two elements. The first is the differences between the loss of fall-leavers and rise-leavers, which for simplicity we will repre-

Table 4

Loss of Fall-Leavers and Rise-Leavers

	Oil	Aerospace	Electronics	TV Receivers	Steel	Auto	Meat	Toys	Women's Clothing	Shoes	Cotton
1. Average earnings loss for *Fall-Leaver* relative to *Fall-Stayer* $L_{FL}=Y_{FL}-Y_{FS}=c_1-c_3$	955 (300)	1284 (151)	351 (472)	−269 (514)	1366 (226)	1380 (300)	1064 (299)	167 (467)	274 (631)	180 (359)	−191 (289)
2. Average earnings loss for *Rise-Leaver* relative to *Fall-Stayer* $L_{RL}=Y_{RL}-Y_{FS}=c_1-c_2$	413 (713)	896 (144)	397 (474)	372 (383)	1521 (219)	1504 (323)	1300 (323)	−366 (471)	554 (747)	476 (393)	127 (274)

Note: Negative signs indicate earnings gains (negative losses). Standard errors are shown in parentheses. Dollar figures are in 1964 dollars.

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[5] The fact that these results are for 1962-65, a period of relatively high unemployment, when comparatively few opportunities for job advancement were available, possibly accentuated the difference between rise and fall-leavers. It would be possible to test this finding by examining the difference over the business cycle.

sent as ΔL. The second is an expression that is a function only of γ. The value of the expression by which ΔL will be multiplied is shown for each industry in the first line of Table 5. The value of the expression has a very broad range, from 0.19 for the meat packing industry to 6.14 in toy manufacturing.

The difference between the losses of fall-leavers and rise-leavers (ΔL) is shown on line 2 of Table 5. A positive number indicates that fall-leaver losses exceed those of rise-leavers, a negative number indicates the reverse. These figures are generally small and are not statistically significant.

Only in aerospace can we reject the hypothesis that fall-leavers and rise-leavers suffer the same losses. This finding is a reflection of the strong correlation between the losses of fall-leavers and rise-leavers in the same industry noted in discussing Table 4.

On the other hand, differences from industry to industry exist and exhibit a distinct pattern. With only two major exceptions, TV and toys, the losses of rise-leavers become progressively larger relative to the fall-leaver losses as the average earnings of the industry's leavers falls.

The adjustment factors, which equal the products of the figures on lines 1 and 2, are presented on line 3. An estimate of the standard error of the adjustment factor, assuming that the value of γ is known with certainty, is shown in parentheses. In several instances the standard error is extremely large. In fact these large standard errors may be considerably underestimated since the value of γ is not certain and relatively small changes in γ can create extremely large changes in the value of the figures in row 1.

Finally the loss of fall-leavers from line 1 of Table 4 is added to the adjustment factor to complete the calculation of the loss due to displacement. These results and the standard error are shown on line 4 of Table 5.

Sizable losses are shown for six industries. These losses are statistically significant in five cases. In aerospace, steel, autos, and meat, the standard errors of the estimates are relatively small, indicating that we can be reasonably confident of the point estimates.

Somewhat surprisingly, displacement is estimated to lead to an earnings gain in five of the eleven industries. In none of these cases, however, do the results approach acceptable levels of statistical significance by which we could reasonably reject the hypothesis that there are neither gains nor losses. It is disappointing that the methodology that was expected to produce unbiased results does not lead to the most reliable estimates. In fact, the unadjusted estimate of the losses of fall-leavers seems to be far more reasonable as point estimates. This can be seen in Table 6, where the loss estimates based on assuming the unadjusted losses of fall-leavers adequately reflect the losses due to displacement, and the loss estimates using the indirect procedure, are shown in percentage terms.

For the five industries that show losses greater than 10 percent, the results using either procedure are relatively close. The correction for attrition, therefore, makes little difference. For the other industries, except electronics, the correction for attritions is so large as

Table 5
Data Elements Used to Calculate Loss Due to Displacements

	Oil	Aero-space	Elec-tronics	TV Receivers	Steel	Auto	Meat	Toys	Women's Clothing	Shoes	Cotton
1. $\gamma/(1-\gamma)$	0.69	1.56	1.70	1.50	0.82	0.22	0.19	6.14	3.76	3.17	5.67
2. Difference in the loss of *Fall-Leavers* relative to *Rise-Leavers* (ΔL)	542 (744)	388 (203)	−46 (669)	−641 (641)	−155 (3[illegible]5)	−126 (481)	−218 (396)	533 (663)	−280 (978)	−296 (522)	−378 (398)
3. Adjustment to the loss of *Fall-Leavers* to reflect displacement $[[(\gamma/1-\gamma)]/\Delta L]$	377 (534)	607 (317)	−78 (1137)	−737 (962)	−128 (258)	−27 (106)	−45 (75)	3274 (4071)	−1053 (3677)	−937 (1655)	−1802 (2257)
4. Displacement loss $[L_{FL} + [\gamma/(1-\gamma)](\Delta L)]$	1332 (613)	1891 (351)	−273 (1223)	−1006 (1090)	1239 (343)	1353 (318)	1019 (241)	3441 (4098)	−779 (3731)	−757 (1693)	−1993 (2275)

Note: Negatives denote earnings gains. Parentheses denote a measure of the standard error of estimates. Dollar figures are in 1964 dollars.

to be implausible. It is not difficult to see that the apparent overcorrection could easily be a result of even small measurement errors at high γs and the large variances surrounding the estimate of ΔL. The four figures in Table 6 marked by asterisks are all cases where $\gamma > 0.75$ and standard error of ΔL is greater than 1,600 or 43 percent of the average earnings figure.

Earnings Losses over Time

The estimates of the earnings loss over the six years following job loss is a convenient summary of the relative displacement costs to workers in different industries. It is, however, an imperfect measure because year-to-year differences are concealed. As can be seen in Table 7, the losses of fall-leavers in the first two years following displacement is substantial in almost all industries. The information in Table 7 also shows that the loss falls substantially in the subsequent four years. For the five industries where the loss remains substantial, there are important differences in the pattern in the latter period.

In autos and steel, the losses were extremely large, initially, but continually narrowed and apparently were eliminated by the end of the sixth year. In the three other industries where initial losses were large — meat, aerospace and oil — the loss remained constant in years three through six. Losses in electronics were also constant through those years, but the initial loss was small.[6] Apparently there is a permanent earnings reduction for workers in these industries. This means that the total discounted value of the loss is larger in these industries and smaller in the steel and auto industry than the undiscounted average loss figures suggest.

Table 6

Percentage Losses of Fall-Leavers and Displaced Workers

	Unadjusted % Loss of Fall-Leavers	Adjusted % Loss of Fall-Leaver to Reflect Displacement
1. Auto	24.3	23.8
2. Steel	23.9	21.7
3. Meat	20.0	19.1
4. Aerospace	18.0	26.5
5. Oil	12.4	17.3
6. Women's clothing	5.9	−16.7*
7. Electronics	5.5	4.3
8. Shoes	4.7	−20.0*
9. Toys	3.6	73.7*
10. TV receivers	−4.6	−17.1
11. Cotton	−5.5	−54.0*

*Indicates industries where $\gamma > 0.75$ and the standard error of ΔL is greater than 1,600.

Table 7

Earnings Losses of Fall-Leavers over Time

Industries Studied	Average Percentage Loss First 2 Years	Average Percentage Loss Subsequent 4 Years
1. Automobiles	43.4*	15.8*
2. Steel	46.6*	12.6*
3. Meat packing	23.9*	18.1*
4. Aerospace	23.6*	14.8*
5. Petroleum refining	12.4*	12.5*
6. Women's clothing	13.3	2.1
7. Electronic components	8.3	4.1
8. Shoes	11.3	1.5
9. Toys	16.1*	−2.7
10. Television receivers	0.7	−7.2
11. Cotton weaving	7.4	−11.5

*Denotes loss estimate is statistically significant at the 5 percent level. Negative indicates gains.

Generalizing the Loss Patterns Across Industries

A key objective of this study was to uncover systematic relationships between industry characteristics and the size of the earnings losses. Successfully identifying these relationships is important for two reasons:

1. It will enhance our confidence that the losses are accurately measured for the industries studied.
2. It will provide a means for projecting the losses in other industries.

Systematic relationships between industry characteristics and the measured losses of fall-leavers were analyzed. This was done rather than examining the displacement loss measured using the more complex method because, as just discussed, the adjustment may be a good indicator of direction but it probably overstates the magnitude of the bias.

Since it is possible that the losses are simply proportional to the earnings of displaced workers, the fall-leaver losses are examined in percentage terms to distinguish more sharply the reasons why losses differ across industries.

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[6] The earnings patterns for workers in all other industries became indistinguishable from the earnings path of workers who did not leave their jobs in year 0.

Patterns in the Losses of Fall-Leavers

The relationship between industry characteristics and losses for each of the eleven industries studied was examined using simple correlations and in a series of regressions. Losses of fall-leavers were calculated as a percent of the earnings of leavers prior to separation (*% Loss*).

Industry characteristics included:

1. The industry's attrition rate (*Attrition*), which was measured as the separation rate of prime-age workers in rising SMSAs.
2. The ratio of prime-age males to total industry employment (*Primale*), derived from tabulations of LEED data.
3. The average earnings of all leavers prior to separation (*Earnings*), which is a proxy for the average skill level of the industry.

The simple correlation among the percent loss and other variables is shown in Table 8. A positive correlation means that a "loss," which is always represented here as a positive number, becomes larger (more positive) as the other variable increases. For instance, the negative correlation between *% Loss* and *Attrition* (−0.821) indicates that the loss becomes *smaller* as the industry's attrition rate rises. The positive correlation between *% Loss* and *Primale* (0.774) indicates that the loss becomes *larger* as the percent of prime age males rises.

Both these relations are in the expected direction, based on human capital theory. Industries with high normal turnover (attrition) are likely to offer jobs where specific training is not important. Thus, workers who leave those industries should not experience large permanent earnings losses. Industries where attrition is low probably offer jobs where specific human capital is very important, and leaving these industries should lead to large earnings losses. The explanation for the strong correlation between the *% Loss* and *Primale* variables possibly can be based on the same argument concerning the degree of specific training in different industries. The prime-age male variable could be a proxy for the proportion of production workers. The supposition is that a far higher percentage of total human capital is industry-specific for production workers than for workers in other occupations.[7]

Additional evidence that a loss of specific human capital is responsible for the size of the earnings loss comes from the finding that the *Earnings* variable is not significant and contributes very little to the explanatory power of the regression when either the *Attrition* or *Primale* variables are included. One could argue that it is not specific human capital, but simply that workers with high earnings experience larger losses. These workers have fewer "better" job opportunities and thus will have more trouble regaining their previous earnings level. This alternative hypothesis is not supported by the regression results.

The "best" regressions are shown in Table 9. Because only eleven observations are included in the data, and there is a high degree of intercorrelation among the explanatory variables, the highest adjusted R^2 occurred with both *Attrition* and *Primale* entered together, although neither coefficient was statistically

Table 8

Correlations among Percentage Loss of Fall-Leavers, Attrition Rate, Prime Age Males Percentage and Average Earnings

	% Loss	Attrition	Primale	Earnings
% Loss	1.000			
Attrition	−0.821	1.000		
Primale	0.774	−0.760	1.000	
Earnings	0.435	−0.550	0.598	1.000

Table 9

Regressions with Percent Loss of Fall-Leavers as Dependent Variable

1. $\%\ Loss = \underset{(0.3)}{4.03} - \underset{(1.4)}{0.13} \times Attrition + \underset{(1.7)}{0.27} \times \text{Primale}$ adj $R^2 = 0.86$ $F(2/8) = 30.5$
2. $\%\ Loss = \underset{(2.0)}{-12.00} + \underset{(4.7)}{0.46} \times Primale$ adj $R^2 = 0.84$ $F(1/9) = 54.2$
3. $\%\ Loss = \underset{(8.5)}{25.6} - \underset{(4.4)}{0.26} \times Attrition$ adj $R^2 = 0.83$ $F(1/9) = 48.4$

Variable description

% Loss = Percent loss of fall-leavers relative to fall-stayers
Attrition = Attrition rate of prime-age males
Primale = Percent of total industry employment that is prime-age males.

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[7] Note that *all* workers studied are prime-age males. This argument is that in manufacturing industries most workers are production workers; thus in industries primarily employing prime-age male workers a high proportion would be production workers. In industries with comparatively few prime-age males, however, most of the production workers must be women or young men; thus the prime-age males are more likely to be in supervisory, managerial, technical-scientific, or similar occupations.

significant at the 95 percent confidence level. Almost as good a fit was obtained with *Primale* alone. *Attrition* alone did slightly worse, with respect to both the standard error and R^2, than *Primale* alone.

In all cases, the regressions were weighted by the inverse of the standard error of the measure of the fall-leaver losses. This was required to correct for the fact that the measurement errors on the independent variables, which were the results of separate regressions, were not equal as required for the minimum variance ordinary least-squares regression. The correction procedure is similar to that used in correcting for heteroscedasticity.

The regressions with *Primale* as an independent variable are particularly useful for projecting the losses of fall-leavers in industries other than those directly studied because the variable can be easily derived from tabulations already compiled from the LEED file or from standard sources. The *Attrition* regressions are less useful, because the variable was based on turnover of prime-age males in areas without heavy overall employment declines, a statistic not currently tabulated from the LEED file and not readily available from other sources. The quit rate in manufacturing in these industries is likely to be of some use in projecting losses but not nearly as good a measure as *Attrition* because the quit rate refers to workers in all sex-age categories. In industries with few prime-age males, the quit rate will, of course, reflect turnover of these other groups.

Summary and Conclusions

The major finding of this study is that earnings losses are likely to be substantial for prime-age workers who are displaced from industries where the rate of attrition is very low and a high percentage of all employees are prime-age men. Earnings over a six-year period after displacement could be reduced as much as 25 percent. For a worker displaced in 1970, such a loss could total over $10.000. The losses are likely to be far less for workers displaced from industries where attrition is high and few prime-age males are in the industry's labor force. Although our measurements for low-loss industries are not nearly as accurate as for industries showing large losses, the losses probably would not average much more than 5 percent over a six-year period and could be considerably less.

Despite some measurement problems affecting estimates for individual industries, the results are intuitively appealing and make good economic sense. In particular, it is reasonable that workers forced to leave industries that normally offer relatively high wages and stable employment have difficulty finding an equally good job. The fact that low-attrition industries also tend to offer high wages suggests that workers employed in these industries have special skills specific to the industry. This also suggests that these workers would have inordinate difficulty finding other employment where their skills can be used effectively.

A few caveats should be attached to these conclusions. First, this study was limited to measuring the earnings losses of prime-age males who returned to work following displacement. Workers of this type may not be in the majority in an actual displacement. Second, this study did not consider the impact on the losses of transfer payments other than severance pay. On the one hand, the loss of nonvested pensions might add considerably to the loss. On the other hand, if we had included unemployment compensation, the estimated loss would have been less. We estimate about half the loss is due to unemployment (rather than reduced wages). Finally the study did not consider nonpecuniary costs such as the psychic cost of adjusting to unemployment, losing friends and familiar working conditions and adjusting to a new working environment.

Although it is theoretically possible that these factors would cancel each other, leaving our overall estimates unchanged, this is by no means certain. There is no reason to expect, however, that these factors would change the relative ranking of industries, in terms of the cost to workers displaced, which is probably the most useful information that we have uncovered for policy purposes.

Literature Cited

1. Ashenfelter, Orley. "Estimating the Effect of Training Programs on Earnings with Longitudinal Data." Paper presented at the Conference on Evaluating Manpower Training Programs, 7 May 1976, Industrial Relation Section, Princeton University.
2. Holen, Arlene. "Losses to Workers Displaced by Plant Closure or Layoff: A Survey of the Literature." *Public Research Institute* (21 July 1976), 257–76.
3. Jacobson, Louis. "Earning Losses of Workers Displaced from the Steel Industry by Imports of Steel." *Public Research Institute* (August 1975), 197–75.
4. Rosen, Sherwin. "Human Capital: A Survey of Empirical Research." Mimeographed. University of Rochester, Department of Economics, discussion paper, January 1976.

Comment

Richard Freeman

Under what conditions are adjustments in the work force due to changes in trade patterns, technological change, or other factors costly to specific groups of workers? How can we estimate these costs?

The Brechling and Jacobson papers deal, in quite different ways, with these important questions. Viewed broadly, the question of the extent or distribution of adjustment costs in a world in which, without specific programs, Hicks-Kaldor compensation is not paid, depends on the level of labor turnover. Consider two possible worlds: one in which workers are permanently attached to enterprises and in which economic benefits are strongly dependent on years of tenure with an employer; and one in which, on average, gross turnover rates are quite high, say 15 percent per year, with numerous workers quitting, being permanently laid off, being newly hired, and so forth. In the former world, changes in demand for labor due to some exogenous shock, such as the reduction of a tariff, will be quite painful to workers: those affected will suffer significant capital losses. In the latter world, losses are small, for job changes are a normal way of life. The extent to which dislocation due to trade (or other factors) is likely to be a major problem depends on which of these worlds we live in or, more properly, on how many of us are permanently attached to enterprises, with considerable firm specific capital, versus how many are normally more mobile.

Brechling's analysis of turnover provides some evidence on this key issue. He deals with BLS time series data on turnover which, on the face of it, suggest that ours is a world of significant mobility and hence relatively little loss (on average) from new dislocations. Average turnover rates in the BLS statistics are high. Separations in manufacturing average 12+ percent a quarter, although *temporary* layoffs are included in the total. Excluding layoffs entirely, quits average 6 percent a quarter giving an annual change of about 25 percent. With *normal* "voluntary" changes of this type, there oughtn't be much "general" problem with dislocations, though obviously certain groups, such as older men with accumulated specific human capital and seniority could be extremely adversely affected by particular changes. If declines in demand for labor can be met by normal quitting and attrition, by reductions in new hires, and so forth, with relatively few permanent layoffs and losses of accumulated specific capital, shifts in the market (ignoring cyclic patterns) would be only of modest concern.

But some of Brechling's evidence suggests that the "high gross turnover" story may be less applicable to our world than at first appears to be the case. In particular, the regression of quits in the durable goods sector yields a *positive* coefficient on $\widehat{\Delta N}$, Brechling's instrumental variable for shifts in demand for labor, which suggests that when demand declines, quits also decline in a sector, thereby increasing the need for layoffs and other involuntary adjustments. This is an odd finding, for it suggests that when demand for an industry falls, people prefer to stay with the sector, despite lower rates of promotion and potentially lower future earnings, rather than to leave. One possible explanation is that the calculations fail to differentiate adequately between broad cyclic changes in demand (which would reduce quits by reducing opportunities to get jobs elsewhere) and industry-specific shifts. Another is that the calculations have failed to allow adequately for the relation between new hires and quits: a large proportion of quits tend to be recent hires and the model controls for this only weakly (with the *W*4 change in employment terms). I have the suspicion that if more work is done on the effect of demand shifts on quits, the perverse results found in the table, which imply that dislocations require many more layoffs than would otherwise be the case, will be overturned. In terms of the costs of adjustment, I hope that would be the case. The particular relation Brechling uncovers enters, it should be stressed, significantly into his final simulations, making attritions less important and dislocations more important than in Hamermesh's earlier work and than one would like.

Jacobson provides explicit estimates of the losses accruing to workers separated from an industry by comparing their earnings with those of persons who stay in the industry. He makes one major and, I believe, correct point about the relation between losses and industry characteristics—namely that losses for prime age adult men are largest in industries where the normal rate of turnover is low. By providing a link between turnover at the industry level and earnings losses, Jacobson ties together the Brechling type of analysis with more traditional studies of earnings losses due to displacement.

The major difficulty with the analysis is that the calculations exclude nonprime age men and women—the prime job losers in many sectors and the vast majority of the work force in six of Jacobson's eleven industries (Table 1). For this group, it is clearly not legitimate to exclude labor market withdrawals from the estimates (as can be done for prime age men). Prime age men constitute but 10 percent of the workers in women's clothing, but they are used to estimate the losses of workers from the industry. To get a valid industry ranking, I would suggest a more complex methodology, involving: (a) estimates of the losses by demographic groups, and (b) estimates of the extent of displacement of those groups. The resultant ordering may be quite similar to that found by Jacobson, but it would surely yield different magnitudes. Losses would probably be raised for workers in the industries with fewer prime age men, as at least some persons might be forced off the job market.

An additional problem in this study is that some of the analysis is based on comparisons of industries that grow in an SMSA with those that are declining. But the evidence given (p. 94) shows little persistence in patterns, raising some problem about the potential inference toward more permanent and extensive dislocations. The likelihood is that losses are understated as a result.

One final point about the economic losses due to change. This concerns the institutional rules by which displaced workers may be able to obtain jobs in the same company. Many collective bargaining agreements contain such provisions and many companies have such policies. Private as well as public "insurance" or redistribution schemes are needed to make sure that those injured by economic changes (which benefit society as a whole) do not bear an enormous cost.

Comment

Harry J. Gilman*

Although the Brechling and Jacobson studies provide new insights into the dynamics of labor markets, their findings are far from definitive. It is worth noting that both studies examine adjustments in the context of general declines in output or general separations rather than in the context of declines in domestic production induced by changes in international trade.

The approach has merit insofar as effects of trade on domestic employment and earnings would be largely determined by the speed and the extent of the adjustments that occur in the domestic labor markets. These adjustments, the authors argue, will be largely determined by the characteristics of the affected industries and by the characteristics of the workers employed in these industries, not by the forces that trigger the decline in production. On the other hand, the duration of unemployment of workers displaced from a particular industry and their reemployment wages are both likely to be influenced by the level of output in other industries. Consequently the force that triggers the cutback may generate an independent effect on the adjustment process.

A second problem is that both studies equate dislocations with displacements from an industry, ignoring the displacements that occur within an industry. In my judgment, this is incorrect; for adjustment costs are likely to be a function of the specific skills of displaced workers. And, if such skills are acquired through on-the-job training or investment, they are more likely to be specific to a single firm than to an industry. For displacements caused by import competition, the approach of the authors may not have biased the results very much. This conjecture follows since import competition is likely to have a simultaneously depressing effect on many firms within an industry. Therefore,the displacements would mainly take the form specified in the models. Nevertheless, to the extent that even declining industries may have some expanding firms, the omission of the effects of the intraindustry shifts in labor would bias the estimates of displacement costs downward.

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*The opinions expressed represent the views of the author, not necessarily the views of the Labor Department.

Brechling's findings are sensitive to the level of aggregation. In his model, a decline in output in a single firm will require proportionately more displacements than will a comparable decline in an entire industry. The difference would be smaller the more narrowly the industry is defined. In addition, it is important to note that Brechling's findings are directly applicable only to the scenario highlighted in his model—a reduction in employment in specific industries with employment and wages in other industries remaining unchanged. Brechling is aware that his particular model may not apply well to the case of trade liberalization, since reductions in output in import competing industries are sooner or later likely to be offset by increases in output elsewhere in the economy. The increase in output in other industries would be expected to increase quits in the declining industries, both because of the employment effect in his model and because of the probable concomitant changes in relative wages.

Aside from the applicability of his findings to the trade situation, Brechling's study addresses only a single dimension of a multidimensional problem. For some purposes, it may be sufficient to know whether required reductions in employment can be accommodated by regular attritions or whether they require displacements. In the context of the estimation of the losses imposed on workers that have to shift from import-competing to other industries, the distinction between regular attrition and displacements is important only to the extent that attritions involve significantly lower costs than displacements. Since regular attritions are by and large voluntary, their costs are by definition lower than those associated with displacements. However, the differences in the costs associated with these two types of separations may be small in the case of declining industries. Although Jacobson's evidence on this point may be unreliable, his estimates of the differences in losses between fall-leavers and rise-leavers suggest that this is in fact the case.

My many reservations notwithstanding, Jacobson's estimates of the monetary losses of displaced workers are superior to those available heretofore. His major innovation was to include in displacement costs losses in future earnings and not just the losses incurred during the initial period of unemployment. For a variety of reasons, the absolute magnitudes of his estimates are less reliable than his ordinal ranking of these costs across industry groups. As I mentioned, his exclusion of intraindustry shifts in employment is likely to understate the magnitude of the loss incurred by the average displaced worker. A further downward bias in his estimates is introduced by comparing the earnings of those who have left an industry with those who did not during the so-called impact year. This second bias arises from the fact that many of those in his control group are likely to be separated from the industry in subsequent years. If that were the case, Jacobson in effect would be comparing the earnings of those who left an industry in year 1 with those who remained in that year but left in subsequent years. And to the extent that separations from an industry result in lower future earnings, the earnings of those in Jacobson's control group are likely to be understated, the extent of the downward bias being greatest for those in sharply declining industries, such as those in the shoe or electronics industries.

In fact, even the earnings of those who remain in a continuously declining industry are unlikely to rise as much or as rapidly as in a stable or expanding industry. Jacobson's contrary evidence derived from his observations on fall-leavers and rise-leavers is presumably based on too few observations, even these observations are not generated from industries that are generally expanding or generally declining.

Among the biases operating in the opposite direction is one that is introduced by the difference in productivity between those who are laid off and those who remain employed. Jacobson assumes that during cutbacks in employment employers will lay off individuals in a random manner from among those with comparable prior wages, comparable tenure, and comparable age. This assumption is questionable. If, as is much more likely to be the case, employers tend to lay off the less productive workers of any given cohort, then Jacobson's estimates of the losses are biased upward.

The data used by Jacobson are deficient in several other respects whose combined influence on his estimates is difficult to assess. To begin with, these data *do not* actually identify those who have lost their jobs and those who remained employed. Instead, they identify those who have and those who have not covered earnings in any given quarter. Jacobson's study is limited to prime-age males (males between the ages of 23 and 53). And undoubtedly, most prime-age males without covered earnings are unemployed. Some of them have no covered earnings either because they have become disabled, have found employment in the uncovered sectors, or have voluntarily withdrawn from the labor force. It should be noted that even the prime-age males include a substantial number of individuals (about 6 percent to 8 percent) who are voluntarily out of the labor force at any given time. Since Jacobson is unable to isolate these various subgroups, his estimates of the losses are far from definitive.

In this connection it is also worth noting that Jacobson eliminated from his sample all individuals who had zero covered earnings for all four quarters in a single calendar year. The reason for this exclusion, I believe, was his assumption that these individuals had probably withdrawn from the labor force or were in uncovered employment. To the extent that some of these individuals were long-term unemployed, their exclusion will bias the estimated losses downward. The exclusion of even those who had actually withdrawn from the labor force is equivalent to placing a value on household activity or leisure time equal to the earnings of those who remained employed. This procedure is likely to overestimate the value of time for those no longer in the labor force and underestimate the losses due to displacements.

As Jacobson recognizes, the costs of displacements in absolute terms are likely to be a function of the region and size of the market in which the displacement occurred, the number of employees displaced, and the general level of economic activity at the time of displacement. Yet these variables by and large have been ignored in Jacobson's work. To the extent that his eleven industries had different regional or size of market distributions or to the extent that the dislocations occurred under different economic conditions, his interindustry differences in costs may not be primarily the result of differences in the amount of specific human capital across these industries. In any event, the impact of these factors could be estimated directly. A similar comment applies to Jacobson's exclusion of fringe benefits. Since the magnitude of these benefits is positively related to the wage levels, Jacobson probably assumes correctly that the inclusion of these benefits will not change the ranking of costs across his eleven-industry group. However, the exclusion of these benefits does affect the levels of these costs.

Future work in this area may be able to incorporate an estimate of the monetary value of at least some of the nonmonetary costs associated with dislocation that the Brechling and Jacobson studies ignored. Such estimates can perhaps be derived with a methodology such as that employed by Sherwin Rosen and Richard Thaler [1] which estimates compensatory wage differentials for differences in risk that are associated with different market activities.

All in all the studies by Brechling and Jacobson have importantly contributed to our understanding of the labor market adjustment process. But there remains a lot to be done.

Literature Cited

1. Rosen, Sherwin, and Richard Thaler. "The Value of Saving a Life." In *Household Production and Consumption*, edited by Nestor E. Terleckyj. National Bureau of Economic Research, Columbia University Press, 1975.

Reply

Louis S. Jacobson

Professor Freeman's major point is that because women and nonprime-age men are excluded in estimates of the average loss in different industries, the average losses, which were measured for prime-age males alone, do not reflect the average losses for the workers in these industries.

As Professor Freeman points out, the most general conclusion of my work is that there is a strong positive association between normal turnover (attrition) in an industry and the size of the per person loss. This association makes sense because having to accept large earnings reductions should be a major factor in inhibiting workers from leaving. What's more, attrition affects the *number* of workers displaced, as well as the average loss for workers. Low attrition industries must adjust to decreases in labor demand by displacing workers to a much greater extent than high attrition industries.

Although it would probably be valuable to study the losses of groups not included in my sample directly, we already know that women and young workers tend to have high attrition rates and we might therefore expect the losses to be low for these groups.

Further, there is a strong positive correlation between the size of the loss I estimated for prime-age males and the proportion of prime-age males in the industry. I would therefore be surprised if the industry ranking or magnitude of the loss for all groups combined was very different from those measured for prime-age males.

Professor Freeman also suggests that the loss for those groups excluded from the sample would be larger than for prime-age males because labor market withdrawal would significantly lower the earnings of the excluded group. The magnitude and direction of the potential bias cannot be analyzed in a few sentences. I believe, however, that the exclusion of labor force withdrawal would not significantly bias the measurement, even for those groups that are very likely to withdraw. Workers who have a higher preference for leisure might withdraw even if they receive job offers identical to those accepted by other workers. Thus, the jobs obtained by those remaining in the labor force could adequately describe available opportunities.

Workers who withdraw would simply value leisure more than the earnings from available jobs.

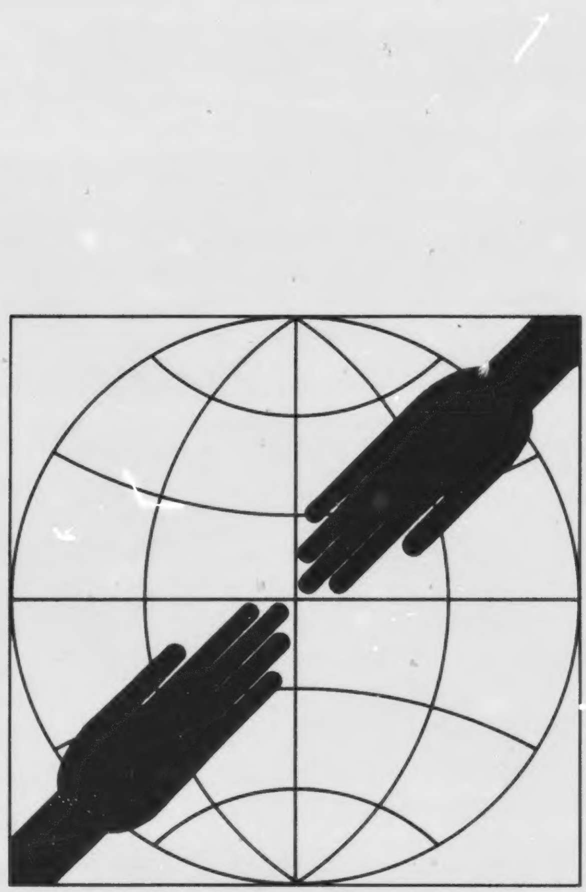
Professor Freeman suggests that the loss may also be underestimated because I measured the loss for workers who separated due to both temporary and permanent employment reduction, whereas in an industry adversely affected by trade liberalization, the decline in labor demand will be large and permanent.

Since all workers in the sample permanently left each industry, the permanence of the decline should not affect the estimated loss for a worker with given personal characteristics. Rather, the net loss (which I did not intend to measure) would be affected because it depends upon the characteristics of workers displaced. The total number of workers displaced in a single labor market, however, could have an important effect. In the steel industry, workers leaving a plant that closed lost about $420 more on average than otherwise similar workers who left operating plants. This could be due to increased competition for jobs among the large number of workers displaced in a plant closing.

There was additional evidence in the steel study that job competition within local labor markets influenced the size of the loss. Labor market conditions, such as the relative unemployment and size of the labor market, were shown to have an important influence on steelworker losses, and could be important in other industries. There is little evidence, however, that either major or permanent declines are distributed very differently from temporary declines. Therefore, the impact of differential labor market conditions on losses in different industries is probably reflected in my estimates. One possibly important influence that was not taken into consideration is the effect of the business cycle on labor market conditions. It is reasonable that losses will be smaller if the decline occurs in a generally prosperous period.

Part Three

Trade Adjustment Assistance



Introduction

Marvin M. Fooks

George Neumann's paper represents the most intensive review of individual worker response to adjustment assistance benefits and the impact of such benefits on individual recipients that has been attempted by the handful of economists who have studied the program.

His findings tend to validate the rationale for the program presented in 1962 when the Congress was considering the program for the first time. Neumann finds that trade displaced workers are different from workers displaced from employment for other reasons. He notes a significant and beneficial program impact on job search efforts at least for males; the results are ambiguous as far as females are concerned. Differences in labor market behavior between men and women are attributed to the compensation effect of trade readjustment allowances. Since job loss costs to women are less than for men, it is conceivable that the program overcompensates some individuals. The basis for this conclusion surely should generate some warm response and discussion.

It is unfortunate that studies such as this one were not available during congressional consideration of the Trade Act of 1974 and its adjustment assistance program. A useful public policy debate on the compensation and adjustment aspects of the program might have resulted in modifications of the program different from those that were enacted.

The new adjustment assistance program enacted as part of the Trade Act of 1974 has been in operation since April 1975. It differs substantially from the Trade Expansion Act program that provided benefits to the workers studied in Neumann's paper. Petitioning and qualifying criteria for groups of workers have been simplified under the Trade Act. Imports need only contribute importantly to worker displacement. A link between a tariff concession and imports does not need to be established. "Contribute importantly" in the Trade Act is defined as referring to a cause that is important, but not necessarily more important than any other cause. With reference to Neumann's findings, this easing of qualifying criteria may result in lessening differences in characteristics of trade impacted workers compared with workers displaced from employment because of other factors.

The criteria for individual eligibility have been simplified to conform closely to individual requirements for unemployment insurance eligibility. This change was made to facilitate delivery of benefits, but it may also result in a caseload of workers eligible for program benefits whose characteristics differ little from those who are not eligible.

Finally, the benefit package has been altered significantly under the Trade Act to provide more generous cash allowances, easier access to training and relocation assistance, and for the first time a cash grant to facilitate job search.

Obviously the new program will have to be studied and evaluated. The Government Accounting Office has a statutory mandate to evaluate the program and report to the Congress by June 1980. The Labor Department will also be allocating some of its research funds for program studies. Thus, one would expect that future studies of worker adjustment assistance would consider the Trade Adjustment Assistance program in the context of trade policy alternatives and their respective labor market costs.

The Direct Labor Market Effects Of the Trade Adjustment Assistance Program: The Evidence from the TAA Survey

George R. Neumann*

In the debate over U.S. foreign trade policy, concern has been raised over the costs of job displacement. Expression of this concern by President John F. Kennedy and by various segments of organized labor was in part responsible for the inclusion of the Trade Adjustment Assistance (TAA) program in the Trade Expansion Act of 1962. The intent of this legislation was to reduce the costs of job loss for workers and to encourage their rapid transferral to new employment. Fifteen years later, comparatively little is known about the effect of the Act on individuals, and to complicate matters, the 1962 Act has been supplanted by the Trade Act of 1974.[1] In it there is a new and more liberal TAA program, particularly insofar as workers on temporary layoffs, in addition to workers who are permanently separated from their jobs, are eligible for benefits. Nevertheless the new program is similar in some respects to the previous one. For example, eligible workers can receive higher unemployment benefits than are available under regular unemployment insurance. It is therefore still timely to examine the effects of the old TAA program on the reemployment experience of trade-impacted workers.

The results from a recently completed survey of trade-impacted workers are reported in this paper. These results provide information about who received assistance under the old program and what its effects were. In section 1 a discussion of the nature of the old TAA program is given. In section 2 the data are described and problems of interpretation are noted. Three findings are of particular note:

- Approximately 40 percent of the sample had not found employment by the date of interview, which in some cases was years after they had lost their jobs.
- The length of time between jobs was unusually high for TAA recipients—61 weeks for females and 39 weeks for males compared with an average of 33 weeks for workers who lost jobs for other reasons.
- Female TAA recipients tended to have substantially longer periods of unemployment than females who did not receive TAA benefits.

In sections 3 and 4 estimates of the impact of TAA on the duration of unemployment and reemployment wages are presented. These estimates indicate that the old TAA program had an impact on males—their weekly earnings were estimated to be 5.42 percent higher than without the program; unemployment duration increased by about 2 weeks. The TAA program had a limited effect on the reemployment of females, providing some evidence that the reported unemployment of females who received TAA benefits was not significantly spent in job search activity.

1. Worker Adjustment Assistance under the Trade Expansion Act: An Overview

The provisions for adjustment assistance to individuals, which are contained in Title III, chapter 3 of the Trade Expansion Act, stipulate four separate services available to certified trade-impacted workers:

- Trade Readjustment Allowances (TRA) for unemployment or underemployment caused by imports
- job training programs
- testing, counseling, and placement services
- relocation expenses.

TRA payments are basically unemployment compensation. These allowances provided for payment of the lesser of 65 percent of the worker's wage or 65 percent of the weekly wage in manufacturing for up to 52 weeks.[2] Most state unemployment compensation payments averaged less than 50 percent of the weekly wage for a shorter period, usually 26 weeks.[3] In effect the federal government compensated the state programs for any regular unemployment insurance payments to trade-impacted workers and, in addition, paid eligible individuals at the higher rate to which they were entitled. This created incentives for both state government programs and the individuals to participate in the TAA program.

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*This paper has benefitted from discussions at the labor workshops of Chicago and Cornell. Helpful suggestions have been made by William G. Dewald, Arlene Hoelen, Harry Grubert, Harry Gilman, and by the official discussant, Joseph Hight. Research assistance by Steve Sheingold is gratefully acknowledged. None of these individuals is responsible for any remaining errors. The paper is based on George R. Neumann, Morgan V. Lewis, and Gerald P. Glyde "An Evaluation of the Trade Adjustment Assistance Program," ILAB 74-23 which was completed in 1976.

[1] Aside from a few in-house case studies conducted by the Bureau of International Labor Affairs, there have been only two significant studies of workers displaced by imports [6,1].

The provision of job training and job placement services depended to a great extent on the existing system within each state. No special funding was allocated for the creation of training centers or of job placement services, "adversely affected workers [were to] be afforded where appropriate, the testing, counseling, training, and placement services provided under any Federal Law."[4] As a consequence, the availability of these services depended upon the existing distribution of services intended for other programs, and upon the level of activity of the different state employment services.

The provision of relocation expenses provided an additional job search incentive, but it was limited in an important way. The program would pay the "reasonable and necessary expenses" of moving, plus a lump sum equivalent to two and one-half times the average weekly manufacturing wage, provided that the individual found employment in another labor market area. Not only was payment made conditional on finding a job, but it was also necessary to convince the program officials that there were no jobs available without moving.

In 1962 these benefits appeared quite liberal but were counterbalanced by stringent eligibility requirements. These requirements took two forms: a particular group of workers had to be certified as eligible—that is, determination had to be made that their unemployment was *caused* by increased imports—and conditional upon this certification, each individual had to meet the following personal standards:

- In the three-year period prior to the impact date, the trade-impacted worker had to have been employed at least 78 weeks at wages of at least $15 a week.
- In the year preceding the impact date, the worker had to have worked at least 26 weeks in the adversely affected firm at wages of at least $15 a week.
- To be eligible for relocation assistance, a worker had to head a household.

The effects of these personal eligibility requirements were twofold: benefits were narrowly focused on the group that Congress felt required assistance, but the administration of the program was made more complex. In particular, since the information required to certify an individual differed from that which was routinely collected for regular Unemployment Insurance purposes by the various state agencies, TAA benefits were likely to be received long after layoff.

A far greater obstacle to the speedy receipt of benefits was the initial certification process. In order for workers to be determined eligible for TAA benefits the U.S. Tariff Commission had to find that the workers' unemployment was caused by increased imports due to concessions granted under trade agreements.[5] There were two options available to displaced workers:

- If an industry had filed for relief with the Tariff Commission and an affirmative finding had been made, workers could directly petition the Secretary of Labor for certification.
- If no industry petition was under consideration, workers in a given firm could petition the Tariff Commission.

Petition to the Tariff Commission was lengthier, since a full investigation of the import situation was required. Nevertheless this procedure was the one most frequently followed. A certification and personal eligibility process that could take many months meant that benefits were received, if at all, long after the onset of a spell of unemployment. In fact, in several cases benefits were not paid until after the trade-impacted worker had found a job.

In spite of the obstacles, there were five petitions for certification the year after the Act was passed. All were denied because of a very strict interpretation of the Act, and the program remained in limbo until President Richard M. Nixon's trade speech in November 1969, which signaled a new birth of the program. Three petitions from the steel industry were quickly approved.[6]

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[2] Under some circumstances a longer benefit period was possible. An individual could have up to 26 weeks additional in order to complete a training program. If the worker was sixty years old by the date of impact he was eligible for 13 additional weeks. By exercising the program to its maximum, a sixty-year-old could have obtained 91 weeks of benefits.

[3] When the Act was written TRA benefits were clearly superior to alternatives under state programs. Subsequent liberalization of payments and duration by many states have reduced the advantage, and presently in some states benefits are more liberal in the short run under the state program.

[4] Public Law 87–794, sec. 326.

[5] There was, and probably always will be, disagreement over what is the "cause" of workers' unemployment. A discussion of the meanings given at various times to sections of the TEA is contained in [7, chap. 1].

[6] In the intervening years the Automotive Products Trade Act (October 1965–June 1968) was in operation during the rationalization of the automotive industry between the United States and Canada. This Act had provisions similar to the TAA program, and fourteen of twenty-one were approved. This indicated that this type of program could be successfully implemented.

There had been 113 successful petitions covering an estimated 51,140 workers and TRA payments amounted to $65.6 million through February 1974. For the entire period 1969–75 the estimated cost was $71.5 million.[7]

Although the incidence of certified unemployment due to tariff reductions was widespread, there were heavy concentrations in certain states and industries. Tables 1 and 2 indicate that the incidence has been particularly heavy in the shoe industry (SIC 31 leather and 30 rubber) and because of this, states such as Massachusetts and New Hampshire have had a relatively large number of cases.

The evidence from these tables indicates that the TAA program as operated under the 1962 Act was relatively small, covering about 45,000 who were certified by May 1974 (and only about 52,000 through 1975), with even fewer workers actually receiving benefits. To a large extent the size of the program was limited by the strictness of the eligibility criteria — only 40 percent of the petitions filed were eventually certified. Since the criteria for eligibility and the role of the Tariff Commission (now the International Trade Commission) have been changed in the new Trade Act of 1974, the size of the new TAA program is substantially larger.

2. Who Are the Trade Impacted Workers?

In October 1975 the Institute for Research on Human Resources of the Pennsylvania State University conducted a survey of trade impacted workers in fourteen states. The individuals covered were all displaced within the four years 1970–73. A total of 916 interviews were completed from three categories:

- TAA: individuals who received TAA benefits;
- QNR: qualified nonrecipients who were separated from plants that received certifications, but who personally did not receive TAA benefits; and
- UI: individuals in the same labor market who were receiving only regular Unemployment Insurance benefits at the same times as those who were eligible for TAA benefits.[8]

Because under the old TAA program, workers generally had to be permanently displaced from their jobs to be considered eligible for TAA benefits, to obtain a comparable UI group the sample includes no individuals on temporary layoffs.

Several features of the population being sampled deserve mention. First, the characteristics and experience of either the TAA or the QNR groups may not be representative of the average worker who loses a job because of increased imports. In several cases the plant closing date was known months in advance, and this

Table 1
Distribution of Trade Adjustment Assistance Petitions by Industry, October 1962–May 1974

Industry	Standard Industrial Classification	Certifications		Denials	
		Petitions	Workers	Petitions	Workers
Metal mining	10	2	0	1	650
Food and kindred products	20	0	0	1	163
Textiles	22	6	2,900	18	10,876
Apparel	23	0	0	3	1,126
Chemicals	28	0	0	2	1,300
Rubber	30	6	4,970	6	3,073
Leather	31	37	11,173	67	13,617
Stone, clay, and glass	32	8	2,320	8	1,920
Primary metals	33	1	400	7	1,982
Fabricated metals	34	3	450	1	200
Nonelectrical machinery	35	2	676	6	3,925
Electrical equipment	36	16	15,025	22	10,205
Transportation equipment	37	2	2,150	3	700
Miscellaneous manufacturing	39	14	4,785	4	5,960
TOTALS		95	44,849	149	55,697

Source: Bureau of International Labor Affairs, U.S. Department of Labor.

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[7] Information for 1969–73 comes from an internal Bureau of International Labor Affairs memorandum dated May 31, 1974. Information for the subsequent period comes from Table 41 of *Unemployment Insurance Statistics*.

[8] The full details for the sampling plan are contained in [7, chap. 3].

Table 2

Distribution of Trade Adjustment Assistance Petitions by State, October 1962–May 1974

State	Certifications Petitions	Certifications Workers	Denials Petitions	Denials Workers
Alabama	1	300	5	3,180
Arkansas	0	0	2	360
California	3	2,300	4	6,155
Connecticut	2	1,710	1	60
Florida	1	350	3	290
Georgia	2	1,730	4	1,790
Hawaii	0	0	1	163
Illinois	8	4,340	5	2,060
Indiana	6	2,540	3	470
Iowa	1	440	0	0
Kentucky	1	700	0	0
Louisiana	1	410	0	0
Maine	2	660	8	2,699
Maryland	1	280	0	0
Massachussets	19	9,873	23	4,866
Michigan	4	1,520	4	830
Missouri	1	130	8	2,260
New Hampshire	10	3,020	4	855
New Jersey	2	890	6	2,353
New Mexico	0	0	1	130
New York	9	5,110	18	4,250
North Carolina	1	250	3	3,062
Ohio	2	126	15	5,650
Oklahoma	1	300	0	0
Pennsylvania	7	2,180	13	8,817
Puerto Rico	0	0	6	1,500
Rhode Island	2	900	0	0
South Carolina	1	220	1	550
Tennessee	2	2,920	3	730
Texas	1	400	1	400
Vermont	1	150	2	472
Virginia	1	450	2	1,130
West Virginia	2	650	2	525
Wisconsin	0	0	1	90
TOTALS	95	44,849	149	55,697

Source: Bureau of International Labor Affairs, U.S. Department of Labor.

may have allowed workers with the greatest mobility to find alternative employment before the plant actually closed. Consequently, such workers would not be eligible for the TAA program and would not be picked up in this sample. The extent of this screening is unknown and caution should be used in extending the characteristics of the TAA recipients in the sample to the wider class of trade-impacted workers.

Second, most of the questions in the survey dealt with conditions at the time of job separation or reemployment, which for some individuals was as long as five years before they were interviewed. The problem of accuracy of recall encountered in all survey data may be especially serious in this survey.

Finally, because the survey covers individuals who were separated from jobs in different years, comparisons of dollar amounts must be adjusted for inflation.[9] In this section all figures are deflated by the consumer price index and are expressed in 1967 dollars.

The characteristics of the sample, classified by sex, benefit group, and reemployment status, are described in Table 3. The most important feature revealed by this table is that roughly 40 percent of the certified workers had not found employment by the survey date. The percentage does not vary by benefit status, but is markedly lower for men (36 percent) than for women (46 percent). Those who did not find jobs are noticeably older than those who did, and therefore are more likely to have been eligible for retirement benefits, but there still remain some relatively young individuals who did not find jobs. The minimum time between layoff and interview was almost two years, and one must conclude that those individuals who did not find jobs at all were withdrawals from the labor force.[10]

The various measures of job search intensity cast further light on the characteristics of workers who found jobs and those who did not. Whether measured by the number of job contacts per week or the number of hours spent searching per week, those who did not find employment searched less on the average than those who did. This may reflect an awareness that job prospects were dim as well as an opportune retirement decision.

Regardless of their reemployment status, workers who lost jobs due to tariff or quota reductions were different from those who lost jobs for other reasons. For example, the TAA and QNR male workers had about twenty years of employment with the firm from which they were discharged compared with only six years for general UI recipients. Part of this difference is accounted for simply by the six- to eight-year difference in age among the group. A broad generalization would be that trade-impacted workers were older, less educated, semiskilled or unskilled, and had a lot of years on the job. It is precisely such workers who could be expected to have a difficult time in finding another job.

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[9] Allowances must also be made for differing conditions in the labor markets both across states and over time, since the period of 1970–74 covered both good and bad times.

[10] Individuals can be laid off after the impact date while the certification is in progress. The individual records indicate that the latest termination was in April 1974, and this individual had found employment.

Although a 40 percent withdrawal rate seems high, placed in the perspective of other studies of mass closings of firms it is not particularly so. See, for example [8].

Table 3

Sample Characteristics: by Sex, Benefit Status, and Reemployment Experience

Characteristics	Reemployed Individuals									Never Found Job								
	TAA			QNR			UI			TAA			QNR			UI		
	Total 309	Males 178	Females 131	Total 112	Males 72	Females 40	Total 115	Males 74	Females 41	Total 208	Males 95	Females 113	Total 86	Males 51	Females 35	Total 86	Males 47	Females 39
Years of education	10.3	10.4	9.7	9.2	9.2	9.3	12.6	12.8	12.1	9.2	9.3	9.1	8.7	9.1	8.2	10.2	10.0	10.4
Dependents	0.9	1.0	0.8	0.8	0.9	0.8	1.2	1.2	1.2	0.4	0.4	0.4	0.3	0.3	0.2	0.6	0.6	0.7
Years of job tenure	17.7	19.2	14.5	16.8	20.4	10.4	5.6	5.9	5.0	22.9	25.9	19.4	22.1	23.9	19.5	7.8	10.4	5.3
Weeks of advance notice of layoff	7.3	7.7	5.0	8.8	12.0	3.0	3.2	3.5	2.6	5.6	5.9	5.2	4.3	5.9	1.9	2.5	1.5	3.3
Weeks of job search before layoff	2.2	2.5	0.3	1.1	1.2	[illegible]	0.7	1.0	0.2	0.5	0.7	0.9	0.4	0.6	−0−	0.9	0.4	1.3
Job contacts per week	3.0	3.2	1.9	3.0	3.7	1.8	2.9	3.0	2.8	1.1	0.9	1.3	0.5	0.6	0.3	2.1	2.4	1.9
Percent white	86.9	87.1	85.5	90.2	97.2	77.5	78.2	78.4	78.0	82.4	72.0	94.8	89.6	88.9	90.5	67.1	67.7	66.7
Percent married	84.8	87.1	71.8	83.9	88.9	75.0	67.8	71.6	61.0	75.0	88.0	59.7	66.8	83.3	42.8	68.4	74.2	63.7
Percent union members	78.5	82.6	55.0	59.0	69.5	40.0	43.5	54.1	24.5	68.9	81.0	54.5	63.7	77.9	42.9	49.9	58.1	43.3
Percent received training	15.2	15.7	12.2	1.8	1.4	2.5	1.7	2.7	0.0	11.1	5.2	18.2	2.0	−0−	4.8	3.2	3.2	3.3
Percent received counseling	19.1	20.2	13.0	3.5	4.1	2.5	4.3	2.7	7.3	10.3	10.3	10.4	2.0	−0−	4.8	9.9	9.7	10.0
Age	46.0	46.0	45.8	46.6	48.1	44.0	38.4	38.2	38.9	55.7	56.8	54.3	56.1	57.0	54.9	48.3	51.0	46.1
B/W*	55.0	53.4	63.9	37.2	34.1	42.9	43.5	39.0	51.6	58.6	55.0	62.9	33.3	34.9	30.9	43.3	37.7	47.8
EB/W†	48.7	47.2	57.5	37.2	34.1	42.9	43.5	39.0	51.6	51.7	47.0	57.2	33.3	34.9	30.9	43.3	37.7	47.8
Percent skilled	20.6	23.0	7.6	21.4	31.9	2.5	35.6	48.6	12.2	12.4	20.7	2.6	11.8	16.7	4.7	22.2	29.0	16.7
Real hourly earnings at layoff ($1967)	3.4	3.6	2.3	2.9	3.3	2.2	3.3	3.9	2.2	3.0	3.5	2.3	2.9	3.5	2.1	2.9	3.5	2.4
Real weekly earnings at layoff ($1967)	140.9	149.2	93.2	121.9	139.6	90.0	132.8	159.6	84.4	123.5	147.9	94.4	124.3	147.7	90.2	117.4	140.1	99.1
DUR1 = number of weeks between layoff and reemployment	48.7	39.4	61.4	32.7	30.8	36.2	33.3	32.6	34.7									
DUR2 = DUR1 minus weeks out of the labor force	44.3	35.7	56.0	31.2	29.6	34.1	28.6	26.2	32.9									
DUR3 = DUR2 minus weeks of job training	39.5	30.3	51.9	31.0	29.6	33.4	28.5	26.0	32.9									
Percent change in real hourly earnings	−26.9	−27.8	−21.7	−24.1	−27.9	−17.5	−13.2	−15.4	−9.1									
Percent change in real weekly earnings	−29.5	−30.1	−25.9	−25.2	−26.4	−23.0	−17.6	−19.0	−15.2									

*Ratio of weekly unemployment benefits and TRA payments to prelayoff weekly earnings.

†Ratio of expected weekly benefits to prelayoff weekly earnings. Expected benefits are defined in the text.

For those workers who did find jobs, the average time between layoff and reemployment was 48.7 weeks for TAA recipients, 32.7 for QNRs and 33.3 for UI recipients. TAA recipients tended to have spells of unemployment between jobs that were 46 percent longer than for UIs and 48 percent longer than for QNRs. If the time that workers were not in the labor force is subtracted, the adjusted duration of unemployment figures are the following: TAA, 44.3 weeks; QNR, 31.2 weeks; and UI, 28.6 weeks. If time spent in training programs is subtracted as well, the average duration figures are TAA, 39.5; QNR, 31.0; and UI, 28.4. These figures indicate that there were substantial differences in the unemployment experience of the various groups. However, Table 3 indicates that the difference is mainly accounted for by the very large difference in the unemployment behavior of female TAA recipients.

Table 4 shows the fraction employed within a given period by benefit status and sex. These results are consistent with previous studies, i.e., women in all categories have longer spells of unemployment than do men. At the end of a year, this difference is reduced to 2.1 percentage points for the UI group due to successful job search or to labor force withdrawal. However, for the TAA group, the difference remains large—13.6 percentage points. Since the male behavior does not differ very much between the TAA and the UI or QNR group, almost all of the difference in the aggregate is due to TAA females being unemployed longer than TAA males.

Turning to the changes in hourly wages and weekly earnings as reported in Table 3, a similar observation can be made. Since the individuals in this sample became unemployed at different times during the period 1970–73, and since this period was one of accelerating inflation, all dollar figures are expressed in constant 1967 dollars. Thus real earnings at layoff is nominal earnings divided by the consumer price index for the month that the individual was laid off, and real weekly earnings at reemployment is nominal earnings at reemployment divided by the consumer price index for the month in which the individual became reemployed. For the TAA group, column 1 shows that real hourly earnings decreased by almost 26 percent, whereas real weekly earnings declined by 28.8 percent. These reemployment wage losses were considerably larger than the losses experienced by workers in either the QNR or the UI groups.

Table 4

Cumulative Employment Percentage of Reemployed Workers

Group	Weeks				
	1	2–13	14–26	26–52	52+
TAA					
Males	19.9	46.4	60.6	81.5	100
Females	10.9	23.7	40.7	67.9	100
Difference	9.0	22.7	19.9	13.6	–0–
QNR					
Males	24.2	59.8	69.0	84.0	100
Females	14.9	37.1	57.5	79.7	100
Difference	9.3	22.7	11.5	4.3	–0–
UI					
Males	12.4	43.8	65.1	89.8	100
Females	2.2	25.2	46.0	87.7	100
Difference	10.2	18.6	19.1	2.1	–0–

Note: Calculations are based on duration of unemployment with time spent in training and out of the labor force subtracted.

Another interesting observation is that over 14 percent of the TAA group received job training compared with only 1.8 percent of the QNR group and 1.7 percent of the UI group. Comparably, 17.1 percent of the TAA group received job counseling, whereas only 3.5 percent of the QNR and 4.3 percent of the UI group received counseling. These services, although important, were not major aspects of the old TAA program, a fact that is reflected in the small percentage of individuals receiving them.

The major part of the program, the provision of TRA payments, can be seen in the ratios of benefits to prelayoff wages, *B/W*, and expected benefits to prelayoff wage, *EB/W*. The former is the ratio of the sum of weekly unemployment benefits and TRA payments to prelayoff weekly earnings—commonly called the replacement rate. Since many benefit payments were delayed, an expected replacement rate was calculated as the ratio of expected benefits to prelayoff earnings. Expected benefits are defined as the sum of unemployment benefits plus the amount of extra TRA payments multiplied by the individual's subjective probability of receiving TRA benefits—i.e., EB = UI payments + α (TRA payments), where α is the probability of receiving TRA benefits. The survey elicited responses about individual's perceived probabilities, as of the date of layoff, of receiving TRA payments. These responses were used to weight the actual benefits received. Benefits should be further discounted to reflect the delay in payment, but, as a practical matter, since the delays were less than a year for the individuals studied, this was not done. The ratio of actual benefits to prelayoff earnings was 6.3 percentage points higher than the ratio of expected benefits to prelayoff earnings.

Finally, the amount of benefits received was computed using the unemployment insurance benefit algorithm for each state, the formula for TRA benefits, and the individual's normal weekly earnings before layoff. Although the survey elicited responses about the amount received from UI and TRA, this information was sufficiently unreliable to necessitate the use of calculations from actual benefit formulae. For example, in some cases, TAA benefits were paid in one check along with UI benefits. In other cases a separate check was paid for each, or only a TAA check was paid. Consequently, individuals had difficulty identifying the two sources of compensation, and for consistency the appropriate benefit formula was used. Based on these calculations, TAA recipients had a higher replacement rate than workers in either of the other two groups. This difference averaged over $18 per week in 1967 dollars not subject to income tax. This amount is not inconsequential.

In summary, the sample indicates that there were significant differences in labor market characteristics between TAA recipients and UI recipients. The effects of the TAA program on the labor market experience of these workers is discussed in the next section.

3. The Effects of the TAA Program on the Job Search Process

The purpose of the TAA program under the 1962 Act was to promote the reemployment of workers and to minimize the loss in earnings. Consequently an evaluation of the effects of the program on individuals must incorporate its effects both on the duration of unemployment and on changes in earnings. As indicated in section 1, changes in the outcome of the job search process due to the TAA program must be attributed to (1) higher replacement rate of earnings under the TAA program, (2) greater access to job training programs, and (3) greater access to job counseling services. To incorporate these possibilities into a simple model we draw on the theory of job search.[11] According to this theory, individuals who become unemployed will continue to participate in the labor market, that is they will search for a job, so long as their anticipated earnings from reemployment exceed the value of their time spent in nonmarket activities. In this interpretation the effect of a decline in anticipated market earnings would be expected to differ across groups to the extent that the value of time in nonmarket activity differs. For example, the presence of children is likely to increase the value of time spent at home, as would the availability of pension income. One would expect then that married women with children and older workers in general would be less likely to become reemployed.

Given that an individual does search for work and is aware of the distribution of wages in the market, an optimal strategy would be to formulate a reservation wage and only accept an offer that exceeded it. The reservation wage may be affected by the TAA program. Such an effect would be expected because higher unemployment compensation levels under this program lower the cost of search, and hence would be expected to increase both the duration of unemployment and reemployment earnings. Unfortunately the data are not ideal to test these propositions fully, since unemployment payments are per period of time and not per unit of search, and there may be a substitution of time for intensity of search. In addition, job training, to the extent that it is effective, would increase an individual's skill level and earnings, although its effect on duration of unemployment is ambiguous.[12]

An empirical representation of the outcome of the job search process is embodied in the following model:

$$DUR = \alpha_1 R + \alpha_2 T + \alpha_3 C + \alpha_4 X_1 + \epsilon_1 . \qquad (1)$$

$$\dot{w} = B_1 R + B_2 T + B_3 C + B_4 X_2 + \epsilon_2 . \qquad (2)$$

DUR = number of weeks of unemployment
$\dot{w}$ = percentage change in weekly earnings (hourly wages) from layoff date to reemployment
R = replacement rate, i.e., unemployment payments divided by previous earnings
T = 1 if an individual received job training, 0 otherwise
C = 1 if an individual received counseling, 0 if otherwise
X_1, X_2 = vectors of exogenous variables
ϵ_1, ϵ_2 = random error terms.

In essence this model was used by Ehrenberg and Oaxaca [3], and by Classen [2] except that effects of training and counseling are added in our specification.

Two issues arise in estimating this model. First, an implication of the theory of search is that the error terms are jointly distributed and that their covariance is negative. That is, individuals who have overestimated their prospects will have longer than average unemployment, and would tend to have lower reemployment earnings if their reservation wage declines over time.[13] On the other hand, as argued above, if expectations are realistic, those with higher reservation wages will on average experience longer durations of unemployment, but will be compensated by higher reemployment earnings. This is the productive investment nature of the search process.

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[11] A detailed description of the theoretical work on the job search process as well as a summary of the previous empirical work pertaining to search duration and subsequent wage change is contained in [7, chap. 2].

[12] In effect job training should offer the individual a different wage offer distribution.

[13] This argument suggests that an efficient estimator such as Zellner's seemingly unrelated regressions estimator be used [9].

The second issue is the possible endogeneity of the decision to participate in training or counseling sessions. Since these services are potentially available to TAA, QNR, and UI groups, perhaps at different prices, the decision to participate in these programs may be based on characteristics of the individual that are related to both wage change and duration of unemployment. For example, it could be that only those individuals who have an expected duration of unemployment greater than some critical value enroll in training programs. If this were the case, the coefficient on training (T) in equation (1) would show that training was associated with a longer duration of unemployment. However, this would be a biased estimate of the true effect of training if the training decision is correlated with the expected outcome of the job search process. Only when the occurrence of training or counseling is beyond an individual's control—e.g., given to everyone in one area, and to no one in another area—can an unbiased estimate of these effects be obtained from equations (1) and (2). The use of appropriate instrumental variable will eliminate this problem when training (T) and counseling (C) are continuous variables. An analogous result has been shown by Heckman [5] when the variable is dichotomous. In essence this requires that the values of T and C, which are either 0 or 1, be replaced by their predicted values from a probit regression. These predicted values have the interpretation of probabilities of receiving training or counseling. The model in (1) and (2) then becomes

$$DUR = \alpha_1 R + \alpha_2 P(T = 1) + \alpha_3 P(C = 1) + \alpha_4 X_1 + \epsilon_1 . \quad (1')$$

$$\dot{w} = \beta_1 R + \beta_2 P(T = 1) + \beta_3 P(C = 1) + \beta_4 X_2 + \epsilon_2 . \quad (2')$$

The probabilities of receiving training and counseling, $P(T = 1)$ and $P(C = 1)$, are the fitted values from the probit regressions. Variations in the determinants of these probabilities due to the TAA program are denoted as

$$\gamma = \frac{\partial P(T = 1)}{\partial TAA} \quad \text{and } \delta = \frac{\partial P(C = 1)}{\partial TAA} .$$

The effects of the TAA program on the job search process can be calculated then as

$$\frac{\partial DUR}{\partial TAA} = \alpha_1 \frac{\partial R}{\partial TAA} + \alpha_2 \gamma + \alpha_3 \delta , \quad (3)$$

$$\frac{\partial \dot{w}}{\partial TAA} = \beta_1 \frac{\partial R}{\partial TAA} + \beta_2 \gamma + \beta_3 \delta , \quad (4)$$

where γ is the marginal effect of TAA participation on the probability of receiving training, and δ is similarly defined for counseling. As (3) and (4) indicate, the total effect of the TAA program has two components. One effect is due to the higher level of unemployment benefits, which alters the cost of unemployment, and hence has a direct effect upon the search process. The other effect is composed of the direct effect that training and counseling have on the search process, multiplied by the increased probability of an individual's receiving them. For these latter effects it is possible that the TAA program had no substantive effect on the job search process, either because the program had no effect on providing these services, or because these services themselves as provided were of no value in the labor market.[14]

Evidence on the likelihood of an individual's receiving job training or counseling is presented in Table 5, and a larger set of results are contained in Tables A1 and A2 of the appendix (a description of the variables is given on p. 115). Examination of columns (1) – (3) reveals that the TAA recipients were significantly more likely to receive training or counseling than were QNR or UI recipients. The coefficient on the variable TAA is positive and significant, regardless of the specification of the equation. (See Tables A1 and A2 of the appendix.) The size of the coefficient refers to the effect of TAA participation on the index variable of the cumulative normal probability function. Translating these effects into probabilities, the coefficient on TAA in column (2) of Table 4 implies that TAA recipients had a probability of receiving training that was 6.72 percentage points higher than without the program. In the notation of equation (3), $\gamma = 0.0672$. For counseling, the estimate of 0.6502 in column (3) implies that δ, the effect of the TAA program on the probability of receiving counseling, was 0.0872. This evidence indicates that the TAA program, as operated under the old Act, provided greater access to job training and job counseling than otherwise would have existed. To be sure, not all individuals received training or counseling; in fact only a small percentage did. Nevertheless, the TAA program appears to have made it easier for recipients to obtain these services.

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[14] At first thought it may seem unlikely that any individual would participate in a program that is worthless in terms of future employment. However, since many training programs pay a subsidy, or, in the case of TAA, enable an individual to receive unemployment benefits for a longer time, there is an incentive to enroll in the program to lower the cost of current job search.

Table 5
Probit Estimates of Training and Counseling Equations, $N = 536$ (asymptotic t-ratios in parentheses)

	Training (1)	Training (2)	Counseling (3)
Constant	−3.6706	−4.0289	−2.1042
	(4.33)	(5.75)	(3.10)
Age	−0.0108		−0.0142
	(1.27)		(1.45)
Schooling	0.0457	0.0461	0.0796
	(1.36)	(1.43)	(2.55)
Job tenure		−0.0215	−0.0048
		(2.06)	(0.47)
Unemployment rate	0.1879	0.1970	−0.0436
	(2.30)	(2.39)	(0.60)
Sex	−0.4032	−0.3717	−0.1751
	(1.74)	(1.60)	(0.94)
Union	0.3380	0.3504	
	(1.30)	(1.36)	
TAA	0.8235	0.9157	0.6502
	(3.35)	(3.60)	(3.26)
Georgia	1.5932	1.7196	1.2000
	(4.08)	(4.33)	(4.36)
Louisiana	1.5924	1.7646	1.9698
	(5.67)	(5.83)	(7.17)
New York	0.6512	0.6099	0.3290
	(2.11)	(1.97)	(1.22)
Rhode Island	0.7512	0.8770	1.2902
	(1.62)	(1.87)	(3.39)
Log of likelihood function	−151.04	−149.44	−186.53

Description of Variables

Age: age at layoff
Schooling: years of formal education
Job tenure: years of employment at the firm from which the individual was terminated
Unemployment rate: local unemployment rate during the quarter in which the individual was laid off
Sex: 1 = male
Union: 1 = union member at layoff
TAA: 1 = received TAA assistance
EB/W: ratio of expected weekly unemployment benefits to previous normal weekly earnings
P(C): probability of receiving job counseling, predicted from column (3) of Table 5
P(T): probability of receiving job training, predicted from column (2) of Table 5
Industry change: found employment in a different two-digit (SIC) industry

Dependent Variables
T: = 1 if the individual received job training
C: = 1 if the individual received job counseling
*DUR*1: number of weeks between layoff and reemployment, less the number of weeks spent in job training, less the number of weeks out of the labor force
*DUR*2: *DUR*1 + number of weeks out of the labor force
$\%\Delta w$: percentage change in gross hourly wages
$\%\Delta w \cdot h$: percentage change in gross weekly earnings.

The effects of variables representing location merit comment. The coefficients reported in the text, and in the appendix, indicate that in some states individuals were more likely to receive training or counseling. Experimentation with different combinations of state variables indicated that the four states shown—Georgia, Louisiana, New York and Rhode Island— differed significantly from the remaining states. However, because some states had only one TAA case, it was impossible to separate differences in the availability of training or counseling due to permanent differences across states, e.g., larger or more efficient programs, from transitory differences due to the peculiarities of a particular TAA case, e.g., advance knowledge of a plant closing. Thus the coefficients reported represent the combined influence of permanent and transitory effects.

Before proceeding to the estimates of the duration of unemployment and wage change equations two questions of measurement should be noted. Since the TAA survey was retrospective, special attention had to be given to making the measure of unemployment as close as possible to the Bureau of Labor Statistics definition. In this survey information was available on (a) the length of time between layoff and reemployment; (b) the number of weeks spent in job training; and (c) the time the individual was not looking for work. If the responses given to (c) are interpreted as time out of the labor force, then the measure of duration represented by $DUR1 = (a) - (b) - (c)$ most closely matches the BLS definition. Examination of the responses indicated that question (c) was interpreted differently by various respondents, hence two measures of duration were used: (c) is not counted as unemployment in *DUR*1 but is counted as unemployment in *DUR*2.[15]

The second issue concerns the measurement of the replacement rate *R*. Due to lags in the delivery of TAA benefits, some individuals did not receive TRA benefits until after they were unemployed for some time. In a few cases, benefits were received after individuals had become reemployed. Many individuals were therefore unable to state the exact weekly amount received. It was necessary, therefore, to calculate benefits for each individual in the sample by use of the appropriate state formula, or in the case of TAA recipients, by the national formula.[16]

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[15] The intent of the question was to distinguish that part of the interval between layoff and eventual reemployment when the individual was not seeking work. In studies that rely on recall, it is difficult to achieve this goal since questions such as those asked in the monthly CPS about job search activity are not suitable.

In addition, since TRA payments were often delayed, a question arises as to how they should be included in *R*. If perfect foresight is assumed, then actual benefits received, suitably discounted, is the correct measure of TRA payments. Since there was uncertainty as to eligibility, it is appropriate to use expected benefits, again with discounting for the delay in receipt of benefits. For this sample, the adjustment for time discounting is negligible, and was ignored. In the estimates that follow the expected benefit ratio is adopted.[17]

The estimates of the duration and wage change equations are contained in Table 6 for the sample of 536 individuals who found employment. The first two columns contain the estimates of equation (1) for the two measures of unemployment, and the last two columns contain the estimates of (2) for weekly and hourly earn-

Table 6
Duration of Unemployment and Wage Change *N* – 536
(*t*-statistics in parentheses)

Dependent Variable	*DUR*1 (1)	*DUR*2 (2)	$\%\Delta w$ (3)	$\%\Delta w \cdot h$ (4)
Constant	13.0617 (1.30)	14.6097 (1.34)	−37.5100 (3.80)	−55.6215 (4.19)
EB/W	0.2195 (1.80)	0.3116 (2.31)	0.4392 (4.15)	0.5944 (4.18)
P(C)	−0.6424 (1.98)	−0.5021 (1.40)		
P(T)	0.6530 (1.67)	0.7726 (1.78)		
Unemployment rate	1.1700 (0.81)	0.2464 (0.15)		
Union	5.5435 (1.39)	1.2992 (0.29)	−8.4620 (2.14)	−7.3792 (1.39)
Industry change	17.4807 (4.25)	19.5888 (4.29)	−8.0164 (2.25)	−11.9749 (2.50)
Sex	−15.7956 (3.70)	−13.9107 (2.94)	−1.7344 (0.48)	7.2949 (1.50)
Schooling			0.6333 (1.11)	1.3549 (1.77)
Job tenure			−0.5152 (3.47)	−0.9553 (4.78)
Rhode Island	40.5557 (3.21)	33.5838 (2.40)		
Georgia			16.4889 (2.76)	21.7907 (2.72)
New York			−4.8897 (1.03)	−12.4871 (1.97)
R^2	0.1113	0.1002	0.1164	0.1104
F	8.2493	7.3419	8.6823	8.1750

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[16] TRA payments were 65 percent of the individuals' previous average weekly earnings or 65 percent of the average weekly earnings in manufacturing, whichever is less. Thus the algorithm used to compute TRA payments does not change, over time, although the upper limit does.

[17] Expected benefits were calculated as the sum of regular UI benefits plus α times the TAA differential. The probability of receiving TAA benefits, α, is taken from question 50 of the survey. (How sure were you of receiving TAA benefits at the time you were laid off?) which was coded 1–5 (very sure, sure, etc.). These answers were ranked as probability assessments ranging from 0.2 (no knowledge) to 1.0 (very sure). The average replacement rate of expected benefits calculated in this manner was 6.3 percent lower than the actual.

ings change. The most important result is that the effect of higher unemployment benefits on both duration and wage change is positive as expected. The coefficient on the expected replacement rate—0.2195 in column (1) and 0.3116 in column (2) imply that an increase in the replacement rate by 10 percentage points would increase *DUR*1 by 2.2 weeks, and *DUR*2 by 3.1 weeks. For recipients of TRA payments, the expected replacement rate was 6.3 percentage points higher; therefore, the effect of higher TRA payments was to increase duration of unemployment by 1.4 weeks (= 0.2195 × 6.3) for *DUR*1 and by 2.0 weeks for *DUR*2. A similar calculation using the coefficients on the expected replacement rate from columns (3) and (4) yields the effect of higher TRA payments on earnings: hourly earnings were 2.7 percent (= 0.4392 × 6.3) and weekly earnings 3.7 percent higher than without the program. One caveat to this is that all of the effects of TRA payments may not have been captured. In particular, the longer potential benefit period for TAA recipients may have a separate, independent effect on both duration and earnings. Preliminary tests of this proposition, using the state maximum UI durations and the TAA maximum duration, did not indicate that this factor was important, but the test was not conclusive because in several states extended unemployment benefits were available; hence potential duration was measured incorrectly. Thus EB/W may be only a rough measure of the true expected replacement rate.

The remaining effects of the TAA program are related to the availability counseling and training. As reported in Tables A4 and A5 of the appendix, no significant effects of training or counseling on earnings could be found; and the effects on duration are hard to interpret. Counseling has the expected sign, but it is insignificant when time out of the labor force is counted as unemployment. (See columns (1) and (2) of Table 6.) This suggests the possibility that time spent between layoff and the provision of job counseling was not spent in job search.[18] The estimates indicate that job training increased unemployment duration—although not significantly. Since the availability of training services was severely limited at the time of layoff for most TAA recipients, the majority of those receiving training did not start until after a considerable period had elapsed. Furthermore, there was an incentive to take training to increase the length of time for which TRA benefits would be paid. Thus the evidence that training had no effects on earnings, coupled with a lengthened duration of unemployment, supports the interpretation that the training programs may have served to provide a type of extended unemployment benefits for those who participated.

The effects of the remaining explanatory variables are of the anticipated sign but are, with a few exceptions, insignificant. For example, there was no significant effect of the local unemployment rate at time of layoff. Union members were estimated to have a slightly longer duration of unemployment, but again the difference was insignificant. All else equal, union members were estimated to experience an 8.5 percent decline in hourly earnings, after a job loss a figure that is large and significant. This effect is compensated somewhat by an estimated increase in their hours worked so that the loss in weekly earnings was 7.4 percent.

The impact of job termination had considerably different effects for men than for women. The coefficients on sex (male = 1) reported in columns (1) and (2) of Table 6 indicate that on the average spells of unemployment for males were 13.9 to 15.8 weeks less than for females. The apparent source of difference is the behavior of female TAA recipients: whereas UI and QNR females had durations that were only 1.7 and 0.9 months longer than for males, TAA females were unemployed for 4.9 months longer. No ready explanation for this difference seems obvious. The estimated change in reemployment earnings is not so different, however.

The effects of human capital accumulation can be seen in the coefficients of schooling and years of job tenure. Years of schooling is a measure of general human capital, and years of job tenure, since it measures the number of years employed at the firm the individual was laid off from, is a proxy for job specific capital. Although neither has an appreciable effect on duration of unemployment, they did have the expected effects on wage change. The effect of education was consistently positive in all specification that controlled for interstate differences. The positive coefficients can be interpreted to mean that job termination does not reduce the value of general human capital. In contrast it was estimated that the reduction of firm specific human capital due to a job loss had a large negative effect; indeed, this variable and the replacement rate are by far the most powerful explanatory variables. Other things equal, the regression coefficients in columns (3) and (4) of Table 6 imply that each additional year of job tenure is associated with a 0.5152 percent decrease in real hourly earnings and a 0.9553 percent decrease in real weekly earnings when an individual loses a job. Thus an

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[18] Evidence of this behavior is partially revealed in the correlation coefficient between various measures of duration and counseling or training:

X	$P_{T,X}$	$P_{C,X}$
1. Time between jobs	0.2734	0.1217
2. Less time in training	0.2020	0.0708
3. Less time "out of labor force"	0.0110	−0.0313

individual with twenty years with one employer would be estimated to have a 10 percent decrease in hourly earnings and an 18 percent loss in weekly earnings.

The inclusion of controls for place of residence at time of layoff was intended to capture any systematic differences across states that were not captured by other variables.[19] For the same reasons as discussed above it is not possible to separate permanent state effects from transitory effects due to individual TAA cases, and interpretation of the coefficients is therefore more difficult. In particular, the estimated impact of Rhode Island on duration is too large to believe. However, the direction of the effect is consistent with the view of several observers that in Rhode Island, more so than in other states, there was wide notice in advance of the TAA program, and that many individuals took advantage of the program.

A final factor of interest is the role of industry change on duration and wage change. This variable was included to measure the effect of the departure of an industry from an area, and hence the loss of whatever industry specific human capital an individual possessed. It appears that the variable is picking up more than this. In particular, since the decision to accept a job in a different industry is voluntary, it may be picking up the effects of unmet expectations. To test this hypothesis we estimated (1) and (2) using Zellner's seemingly unrelated estimator but obtained no substantial difference in the estimates. The reason for no difference between equations (1) and (2) was the low correlation of the disturbances.[20] When industry change is deleted from both equations and the Zellner estimator is used, the correlation of the error terms is significant, but the remaining coefficients are not altered significantly.

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[19] In addition to the local unemployment rate we also included the average manufacturing wage in the SMSA, manufacturing employment as a percent of nonfarm employment, and the ratio of trade impacted workers to manufacturing employment. When the state variables were included, none of these had an effect.

[20] The variance-covariance matrix of one equation of a two-equation system can be written for Zellner's estimator as $V_1 = (1-P^2)\{\sigma_1^{-1}(X_1'X_1) - P^2\sigma_1^{-1}X_1'X_2(X_2'X_2)^{-1}X_2'X_1\}^{-1}$. If P, the correlation coefficient of the residuals, equals zero, this reduces to the OLS estimator.

Table 7

Duration of Unemployment and Wage Change
Males, $N = 324$ (t statistics in parentheses)

Dependent Variable	*DUR*1	*DUR*2	%Δ*w*	%Δ(*w*·*h*)
Constant	−16.037	−13.616	−40.532	−44.780
	(1.24)	(0.94)	(2.99)	(2.49)
EB/W	0.2409	0.3506	0.5178	0.6608
	(1.57)	(2.04)	(3.57)	(3.44)
P(C)	0.4108	0.3259		
	(1.14)	(0.80)		
P(T)	−0.7595	−0.4243		
	(1.72)	(0.85)		
Unemployment rate	3.2976	2.6607		
	(1.71)	(1.22)		
Union	9.4243	4.0804	−11.4703	−10.9044
	(1.68)	(0.64)	(1.88)	(1.35)
Industry change	16.4459	18.7866	−3.6296	−2.8392
	(2.97)	(3.01)	(0.68)	(0.40)
Schooling			0.5203	0.7678
			(0.66)	(0.74)
Tenure			−0.6640	−1.2530
			(3.31)	(4.72)
Georgia			17.8231	21.5046
			(1.71)	(1.62)
New York			−2.0596	−9.5456
			(0.27)	(0.97)
R^2	0.0636	0.0542	0.1032	0.1232
F	2.3135	3.0323	5.1957	6.3449

The pattern of results thus far suggests that a separate investigation of male and female behavior would reveal greater insight into the workings of the TAA program. The results of reestimating the model on the samples of 324 males and 212 females who were reemployed are contained in Tables 7 and 8. Although the explanatory power of each is not very high, pronounced differences in response to unemployment compensation are revealed. Higher unemployment benefits were estimated to increase duration and to lead to higher reemployment wages for men. Reemployment earnings of women were estimated to increase as a result of higher unemployment compensation but no effect can be found on duration. This is rather difficult to understand. Conceivably there were two different types of responses. To analyze this possibility further, the duration equation was estimated with various subsamples of females. The results appear in Table 9. When females are split into married—spouse present and all others, a marked improvement in the explanatory power of the model is observed. Unmarried women, although their numbers are small, behave somewhat more like men as measured by their response to higher unemployment benefits. Married women, on the other hand, seem to have no significant response to higher benefits. Also, it is married women who account for the perverse training effect. Males were estimated to experience shorter spells of unemployment as a result of training, although the significance level is not very high. Training does not appear to have any significant effect on unemployment for unmarried women. For married women, however, training prolonged unemployment by about two weeks (exclusive of the time spent in training), and the effect is highly significant.

4. Summary and Conclusions

The empirical findings of the previous section imply that the TAA program under the 1962 Trade Expansion

Table 8
Duration of Unemployment and Wage Change Females, $N = 212$ (t statistics in parentheses)

Dependent Variable	*DUR*1	*DUR*2	$\%\Delta w$	$\%\Delta(w \cdot h)$
Constant	9.1321 (0.65)	13.466 (0.92)	−32.1122 (2.51)	−58.7951 (3.31)
EB/W	0.0460 (0.21)	0.1007 (0.44)	0.2611 (1.73)	0.3902 (1.86)
P(C)	−0.6822 (2.18)	−0.4504 (1.35)		
P(T)	1.3471 (3.95)	1.5795 (4.33)		
Unemployment rate	2.1849 (1.16)	0.6630 (0.33)		
Union	8.5420 (1.36)	7.5177 (1.12)	−4.9504 (1.03)	−2.4647 (0.37)
Industry change	20.3349 (3.28)	20.6742 (3.13)	−12.5833 (2.79)	−22.2228 (3.55)
Schooling			0.8313 (1.06)	2.4975 (2.29)
Tenure			−0.1334 (0.60)	−0.3039 (0.99)
Rhode Island	26.3951 (1.56)	14.0497 (0.77)		
Georgia			13.3665 (2.01)	20.2965 (2.20)
New York			−6.2855 (1.13)	−13.0331 (1.69)
R^2	0.1880	0.1953	0.1021	0.1268
F	6.7475	7.0761	3.3169	4.2346

Table 9

Duration of Unemployment Married Women—Spouse Present, and All Other Women

	All Other	Married Women—Spouse Present
Constant	27.6838	7.5112
	(1.50)	(0.39)
EB/W	0.3274	0.0342
	(1.11)	(0.11)
$P(C)$	−0.4634	−1.0878
	(1.16)	(2.47)
$P(T)$	0.1674	1.9212
	(0.34)	(4.05)
Unemployment	2.1068	2.7626
	(0.70)	(1.19)
Union	−15.5488	15.1612
	(1.52)	(1.93)
Industry change	18.6655	17.0112
	(2.12)	(2.08)
Rhode Island	60.9507	19.7375
	(2.29)	(0.90)
R^2	0.2044	0.2237
F	2.0190	5.8075
N	63	149

Act had a small but significant effect on at least part of the recipient population. As described in equations (3) and (4), the net effect of the TAA program is the sum of the separate effects of: (a) higher benefits while unemployed (the difference between TRA payments and what would have been received under regular Unemployment Insurance); (b) a greater probability of receiving job training; and (c) a greater probability of receiving job counseling. For male TAA recipients the net effect on unemployment (*DUR*2) and weekly earnings is computed from (3) and (4) using the regression coefficients from columns (2) and (4) of Table 7 as:

$$\begin{aligned}\frac{\partial DUR2}{\partial TAA} &= 0.3506(8.1) - 0.4243(0.0672) \\ &\quad + 0.3259(0.0812) \qquad (5) \\ &= 2.84 \text{ weeks.}\end{aligned}$$

$$\begin{aligned}\frac{\partial(\Delta w \cdot h)}{\partial TAA} &= 0.6608(8.1) \qquad (6) \\ &= 5.4\%.\end{aligned}$$

For the average male TAA recipient duration of unemployment increased by 2.8 weeks (1.9 for *DUR*1). This increase in duration appears to have been used in productive job search, since weekly earnings were 5.4 percent higher than would otherwise have occurred.

For women the results are less clear. Estimates of the net effect of the program on duration of unemployment range from zero to a one-week increase, but these estimates are not significant for the entire sample of women. There is some indication (see columns 3 and 4 of Table 8) that higher unemployment benefits lead to increased reemployment earnings—2.3 percent for weekly earnings and 1.5 percent for hourly earnings—but the evidence is not strong. The pronounced difference in the behavior of males and females is perhaps the major finding of this study in regard to the operation of the program. These results indicate that for the most part women TAA recipients who were married did not search for a job while unemployed. It seems likely that their average of 61 weeks between jobs was due in part to the higher benefits available under the TAA program. This interpretation is reinforced by the finding that unmarried women respond to higher unemployment benefits in essentially the same way as men do. One may tentatively conclude that the provision of higher benefits to families with more than one wage earner can make receiving those benefits an attractive alternative to employment.

Further insight into the differential labor market behavior of men and women is revealed by observing the income maintenance role of the TAA program. Although the 1962 Act was not specifically intended to compensate individuals for job losses, higher TAA benefits while unemployed certainly has this effect. In Table 10 estimates of the net present value of the private costs of job loss are presented under three different assumptions.

1. The value of time while unemployed is zero and all wage loss is permanent.

Table 10

Private Costs of Job Loss for Workers Who Received Trade Adjustment Assistance by Reemployment Status and Sex, 1975 Dollars

	Assumptions:		
Group	1	2	3
A. Never Found Jobs			
Males	47,273	7,644	7,644
Females	18,934	1,452	1,452
B. Reemployed			
Males	29,895	25,690	4,704
Females	11,002	6,543	−481
C. Average TAA Recipient	26,322	11,860	3,293

2. The value of time while unemployed is 50 percent of previous earnings for males, and 65 percent of previous earnings for females; all wage loss is permanent.[21]
3. The value of time is as in 2 and all wage loss is transitory, disappearing in three years.

These calculations should be interpreted as upper-bound estimates of the private cost of job displacement for this particular group of individuals, and not for all individuals who change jobs due to import competition. These estimates are biased upwards, since they do not allow for differential unemployment rates, for job loss due to health reasons, for the value of any pensions received, and for differing marginal tax rates among individuals.[22] Two points are of primary importance. First, the costs of a job loss tend to be smaller for women for three reasons: their lower market earnings, relatively higher nonmarket opportunities, and higher replacement rates of earnings while unemployed. Each factor should make married females less sensitive to labor market programs designed to foster job search activity. Second, and perhaps most important, the private costs that individuals bear depends critically upon the extent to which a loss in earnings potential is permanent. If the loss is transitory, as is assumed in column 3 of Table 10, then it is possible that the TAA program can overcompensate some individuals. This possibility is enhanced for individuals facing high marginal tax rates.

The evidence presented in this paper concerning the labor market effects of the TAA program pertains only to the program as operated under the Trade Act of 1962, and thus the findings are not necessarily indicative of future behavior under the new Trade Act of 1974. Apart from changes such as an increase in the replacement rate to 70 percent from 65 percent, and that workers may be eligible for benefits even though they are not permanently displaced from their jobs, the new worker adjustment assistance provisions are not very different, and thus there are some grounds for extrapolating the results of the survey reported in this paper to the new TAA program. Some, but it is hoped not all, of the difficulties noted may continue to occur. The two major problems that have significant labor market consequences are the delivery of benefits and the level of benefits. The cumbersome nature of the certification process, which existed in the old program in order to focus benefits narrowly, resulted in lengthy delays between the date of job loss and the date when benefits were received. This had the effect of reducing the impact of TRA payments on the job search activity of individuals by almost one-half of the extra benefits. The dilemma is a familiar one; more intensive eligibility criteria direct resources where Congress intended them, but also delay their receipt, making them less useful.

The level of benefits provides a comparable dilemma. Higher benefits can lead to better job matches for some workers, but for others, particularly married women with spouse present, there is no obvious gain other than an income transfer. The dilemma in this case is that equal TAA benefits for primary and secondary income earners in a household may, due to the higher marginal tax rate facing the secondary worker, result in withdrawal from the labor force during the period that benefits are available. This is an effect opposite to that intended if the TAA program was designed to stimulate job search and reemployment.[23] In any event the program can serve as a vehicle for compensating workers laid off because of increased foreign trade, especially if the connection between benefits received and unemployment were severed. One may speculate that this view could become more generally applicable if the administration of the new TAA program turns increasingly towards compensating workers who are only temporarily laid off due to imports and who do not expect to suffer any wage loss upon reemployment.

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[21] The estimates for women are based on [4] with rough adjustment made for the older nature, and fewer dependents, of this sample. Comparable values for males are available (except for the inappropriate measure of commuting time value), and the 50 percent figure is little more than an educated guess.

[22] In performing these calculations a tax rate of 28.4 percent was used.

[23] As an example of the potential size of the benefits consider the case of an individual who lost his job in manufacturing during June of 1976. Eligible for TRA payments and earning the average for manufacturing at this time—$208.06 per week—if he stayed unemployed for the full 52 weeks he would receive $7,573. If he were fully employed and faced an average tax rate—income, social security—of 28.4 percent, then he would have netted $7,746—a difference of only $173. This ignores the effect of fringe benefits and non-pecuniary rewards, but it also ignores work related expense. The point is that the program can subsidize a large part of lost earnings and may reduce the incentive to work.

Table A1
Probit Estimates of the Probability of Receiving Job Training $N = 536$
(Asymptotic t-values in parentheses)

	Regressions				
Variable	(1)	(2)	(3)	(4)	(5)
Constant	−3.8367	−3.8424	−3.6706	−4.0289	−3.4388
	(3.85)	(4.19)	(4.33)	(5.75)	(7.77)
Number of dependents	−0.0463	−0.0398			
	(0.69)	(0.61)			
Age	−0.0022	−0.0023	−0.0108		−0.0024
	(0.18)	(0.20)	(1.27)		(0.23)
Schooling	0.0443	0.0434	0.0457	0.0461	0.0074
	(1.32)	(1.30)	(1.36)	(1.43)	(0.24)
Job tenure	−0.0211	−0.0217		−0.0215	0.0091
	(1.73)	(1.80)		(2.06)	(0.92)
Unemployment rate	0.1899	0.1941	0.1879	0.1970	0.2499
	(2.28)	(2.34)	(2.30)	(2.39)	(4.53)
Sex	−0.3546	−0.3626	−0.4032	−0.3717	−0.1113
	(1.51)	(1.55)	(1.74)	(1.60)	(0.61)
Race	−0.1027				
	(0.39)				
Urban/Rural (1 = urban)	0.0977				
	(0.22)				
Union	0.3317	0.3449	0.3380	0.3504	
	(1.26)	(1.33)	(1.30)	(1.36)	
TAA (1 = recipient)	0.9312	0.9179	0.8235	0.9157	0.9748
	(3.62)	(3.60)	(3.35)	(3.60)	(4.18)
State dummies:					
Georgia	1.6566	1.7076	1.5932	1.7196	
	(4.02)	(4.30)	(4.08)	(4.33)	
Louisiana	1.7495	1.7722	1.5924	1.7646	
	(5.26)	(5.82)	(5.67)	(5.83)	
New York	0.6032	0.6108	0.6512	0.6099	
	(1.88)	(1.97)	(2.11)	(1.97)	
Rhode Island	0.8674	0.8706	0.7512	0.8770	
	(1.79)	(1.86)	(1.62)	(1.87)	
Log of likelihood function	−149.14	−149.25	−151.04	−149.44	−176.91

Table A2

Probit Estimates of the Probability of Receiving Job Counseling and Testing $N = 536$ (Asymptotic t-values in parentheses)

	Regressions						
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	−1.7882	−2.1042	−2.001	−2.7447	−2.6978	−2.8782	−2.4158
	(2.20)	(3.10)	(5.40)	(5.10)	(5.00)	(6.72)	(4.33)
Number of dependents	−0.0786		−0.0402				
	(1.14)		(0.67)				
Age	−0.0206	−0.0142					−0.0147
	(1.97)	(1.45)					(1.62)
Schooling	0.0682	0.0796	0.0919	0.0835	0.0849	0.0847	0.0408
	(2.21)	(2.55)	(3.20)	(2.90)	(2.92)	(2.92)	(1.50)
Job tenure	−0.0077	−0.0048			−0.0127	−0.0123	0.0210
	(0.74)	(0.47)			(1.49)	(1.45)	(2.40)
Unemployment rate	−0.0640	−0.0436	−0.0321	−0.4769	−0.3943		0.1281
	(0.84)	(0.60)	(0.44)	(0.66)	(0.54)		(2.61)
Sex	−0.1627	−0.1751	−0.2189		−0.1764	−0.1888	−0.0514
	(0.83)	(0.94)	(1.19)		(0.95)	(1.03)	(0.32)
Race	0.3463						
	(1.25)						
Union	−0.1065						
	(0.49)						
TAA	0.6731	0.6502	0.5663	0.6649	0.6397	0.6396	0.7167
	(3.33)	(3.26)	(2.96)	(3.39)	(3.23)	(3.23)	(4.01)
State dummies:							
Georgia	1.1653	1.2000	1.1045	1.2207	1.1852	1.2243	
	(3.56)	(4.36)	(4.10)	(4.52)	(4.35)	(4.64)	
Louisiana	2.0712	1.9698	1.8324	1.9275	1.9688	1.8897	
	(7.15)	(7.17)	(7.05)	(7.13)	(7.15)	(8.15)	
New York	0.3076	0.3290	0.3084	0.3164	0.2840	0.2474	
	(1.12)	(1.22)	(1.16)	(1.20)	(1.06)	(0.96)	
Rhode Island	1.2979	1.2902	1.2907	1.3533	1.3308	1.3022	
	(3.35)	(3.39)	(3.41)	(3.58)	(3.51)	(3.47)	
Log of likelihood function	−184.18	−186.53	−188.50	−188.05	−187.60	−187.75	−197.75

Table A3

Duration of Unemployment

N = 536

Variable	DUR1 (1)	DUR1 (2)	DUR1 (3)	DUR1 (4)	DUR2 (5)	DUR2 (6)	DUR2 (7)	DUR2 (8)
Constant	14.8244 (1.48)	13.0617 (1.30)	9.0322 (0.89)	6.9087 (0.69)	16.7560 (1.49)	14.6097 (1.34)	11.8905 (1.06)	9.5144 (0.86)
B/W	0.1739 (1.52)		0.2075 (1.78)		0.2530 (1.97)		0.2813 (2.19)	
EB/W		0.2195 (1.80)		0.2643 (2.16)		0.3116 (2.31)		0.3487 (2.59)
P(C)	−0.6475 (1.99)	−0.6424 (1.98)	−0.2477 (0.81)	−0.2517 (0.83)	−0.5074 (1.41)	−0.5021 (1.40)	−0.1715 (0.51)	−0.1786 (0.53)
P(T)	0.6527 (1.66)	0.6530 (1.67)	0.2239 (0.60)	0.2349 (0.63)	0.7695 (1.77)	0.7726 (1.78)	0.4092 (0.99)	0.4264 (1.04)
Unemployment rate	1.1758 (0.81)	1.1700 (0.81)	2.0328 (1.41)	2.0048 (1.39)	0.2614 (0.16)	0.2464 (0.15)	0.9812 (0.61)	0.9377 (0.59)
Union	5.5763 (1.38)	5.5435 (1.39)	7.4447 (1.85)	7.3344 (1.83)	1.3000 (0.29)	1.2992 (0.29)	2.8746 (0.65)	2.7823 (0.63)
Industry change	17.4395 (4.23)	17.4807 (4.25)	17.1439 (4.11)	17.1954 (4.14)	19.4868 (4.27)	19.5888 (4.29)	19.2384 (4.19)	19.3226 (4.22)
Sex	−16.1919 (3.78)	−15.7956 (3.70)	−17.8212 (4.15)	−17.2629 (4.03)	−14.3951 (3.04)	−13.9107 (2.94)	−15.7638 (3.33)	−15.1257 (3.21)
Rhode Island	41.4941 (3.29)	40.5557 (3.21)			34.8563 (2.49)	33.5838 (2.40)		
R^2	0.1096	0.1113	0.0914	0.0939	0.0978	0.1002	0.0871	0.0904
F	8.1108	8.2493	7.5853	7.8209	7.1431	7.3419	7.2020	7.4989

Table A4
Percent Change in Real Hourly Earnings
N = 536

	Dependent Variable = Percent Change in Real Hourly Earnings					
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Constant	−33.4666 (3.35)	−37.5100 (3.80)	−35.7926 (3.52)	−39.8347 (3.95)	−21.3939 (2.39)	−25.2520 (2.85)
B/W	0.3393 (3.37)		0.3486 (3.41)		0.3086 (3.06)	
EB/W		0.4392 (4.15)		0.4461 (4.22)		0.4028 (3.81)
P(C)			−0.1325 (0.48)	−0.1609 (0.59)		
P(T)			−0.0523 (0.17)	−0.0167 (0.05)		
Schooling	0.6408 (1.12)	0.6333 (1.11)	0.8442 (1.36)	0.8556 (1.39)	−0.0521 (0.09)	−0.0749 (0.14)
Tenure	−0.5406 (3.62)	−0.5152 (3.47)	−0.4843 (3.15)	−0.4573 (2.99)	−0.4614 (3.12)	0.4341 (2.95)
Sex	−2.5580 (0.70)	−1.7344 (0.48)	−2.4639 (0.67)	−1.6774 (0.46)	−3.1365 (0.85)	−2.3197 (0.63)
Union	−8.2154 (2.06)	−8.4620 (2.14)	−7.6942 (1.92)	−7.9724 (2.00	−12.4845 (3.59)	−12.6912 (3.69)
Industry change	−8.0928 (2.26)	−8.0164 (2.25)	−7.4438 (2.07)	−7.3691 (2.06)	−8.0899 (2.24)	−8.0315 (2.24)
Georgia	16.3379 (2.72)	16.4889 (2.76)	17.9680 (2.93)	18.1861 (2.98)		
New York	−4.1388 (0.87)	−4.8897 (1.03)	−4.4123 (0.88)	−5.3480 (1.07)		
R^2	0.1067	0.1164	0.1120	0.1215	0.0906	0.0992
F	7.8744	8.6823	6.6240	7.2674	8.7855	9.7115

Table A5
Percent Change in Real Weekly Earnings
***N* = 536**

	Dependent Variable = Percent Change in Real Weekly Earnings					
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Constant	−50.7468	−55.6215	−49.8486	−54.7568	−35.0236	−39.5097
	(3.79)	(4.19)	(3.63)	(4.03)	(2.90)	(3.30)
B/W	0.4694		0.4732		0.4187	
	(3.47)		(3.48)		(3.08)	
EB/W		0.5944		0.5950		0.5322
		(4.18)		(4.17)		(3.73)
P(C)			0.1996	0.1614		
			(0.53)	(0.43)		
P(T)			−0.2626	−0.2142		
			(0.64)	(0.52)		
Schooling	1.3702	1.3549	1.2301	1.2411	0.3486	0.3151
	(1.78)	(1.77)	(1.47)	(1.49)	(0.48)	(0.44)
Tenure	−0.9897	−0.9553	−0.9954	−0.9595	−0.8553	−0.8196
	(4.93)	(4.78)	(4.81)	(4.65)	(4.29)	(4.12)
Sex	6.3201	7.2949	6.3377	7.2739	5.6618	6.5889
	(1.29)	(1.50)	(1.28)	(1.49)	(1.14)	(1.34)
Union	−7.1130	−7.3792	−6.7116	−7.0304	−11.9743	−12.1634
	(1.33)	(1.39)	(1.24)	(1.31)	(2.55)	(2.62)
Industry change	−12.1023	−11.9749	−11.9837	−11.8662	−12.1190	−12.0154
	(2.52)	(2.50)	(2.47)	(2.46)	(2.49)	(2.41)
Georgia	21.6301	21.7907	21.1409	21.3947		
	(2.68)	(2.72)	(2.55)	(2.60)		
New York	−11.5000	−12.4871	−10.1823	−11.4101		
	(1.80)	(1.97)	(1.50)	(1.69)		
R^2	0.1014	0.1104	0.1021	0.1108	0.0794	0.0868
F	7.4359	8.1750	5.9745	6.5483	7.6042	8.3891

Literature Cited

1. Bale, Malcolm D. "Adjustment to Freer Trade: An Analysis of the Adjustment Assistance Provisions of the Trade Expansion Act of 1962." Ph.D. dissertation, University of Wisconsin, 1973.
2. Classen, Kathy. "The Effect of Unemployment Insurance on the Duration of Unemployment and Subsequent Earnings." *Industrial and Labor Relations Review*, in press.
3. Ehrenberg, Ron, and Ron Oaxaca. "Unemployment Insurance, Duration of Unemployment, and Subsequent Wage Gain." *American Economic Review*, 66 (December 1976), 754–66.
4. Gronau, Reuben. "The Interfamily Allocation of Time: The Value of Housewives' Time." *American Economic Review*, 63 (September 1973), 634–51.
5. Heckman, James. "Simultaneous Equations Models with Both Continuous and Discrete Endogenous Variables With and Without Structural Shift in the Equations." Mimeographed. Chicago: University of Chicago, November 1975.
6. McCarthy, James E. *Trade Adjustment Assistance: A Case Study of the Shoe Industry in Massachusetts*. Boston: Federal Reserve Bank of Boston, June 1975.
7. Neumann, George et al. "An Evaluation of the Trade Adjustment Assistance Program." Report submitted to the Bureau of International Labor Affairs, U.S. Department of Labor, under contract.
8. Wilcocke, Richard, and Walter Franke. *Unwanted Workers: Permanent Layoffs and Long-Term Unemployment*. Glencoe, Ill.: The Free Press of Glencoe, 1963.
9. Zellner, Arnold. "An Efficient Method for Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias." *Journal of the American Statistical Association*, 57 (June 1962), 348–68.

Comment

Joseph Hight

The study by George Neumann is similar to some recent empirical studies on the effect of unemployment insurance benefits on the duration of unemployment and on reemployment earnings [1, 2, 3, 4]. The most notable difference in this study is the inclusion of training and counseling variables in the regression analysis. Since an apparent objective of the Trade Adjustment Assistance (TAA) Program is to increase trade-impacted workers' access to training and counseling services, this is important.

The data Neumann used are from a sample of unemployed workers, of whom some received TAA and some received only regular unemployment compensation. However, although Neumann's model uses the information regarding receipt of TAA to predict probabilities of receiving training and counseling, it does not use this information to estimate either the duration of unemployment or wage changes. In Neumann's analysis, the only purpose served by the use of data that includes TAA as well as non-TAA recipients is that it increases the variance of the benefit-wage replacement ratio.

One aspect of TAA that the Neumann analysis fails to consider is the certification process for groups of workers. Crucial to an evaluation of TAA is an assessment of how accurately trade impacted workers are being identified, for if the wrong workers are being certified then evaluation of the effects of treatment of these workers may be pointless.

When designing a study of the effect of a program that provides special services to those who become unemployed because of trade policy impacts, it is important to ask what it is about trade-impacted unemployment that justifies separate treatment from unemployment in general. Two answers occur to me.

The first is that losses resulting from unemployment due to trade impacts are, on average, greater than losses incurred from unemployment generally, because of (1) capital losses resulting from decreased demand for the industry specific human capital of the trade-impacted workers and perhaps due to loss of seniority rights and (2) higher adjustment costs involved when taking a job in a different industry. This suggests that we compare the losses incurred by the TAA recipients with those incurred by the non-TAA group. Neumann has not done this in his paper, but I believe his data and his results should allow him to do so.

The second difference between trade-impacted workers and the unemployed generally is that the search invironments of the two groups differ. I would suggest that trade-impacted workers know less about the wage offer distribution which confronts them, than do the unemployed in general. In addition, trade-impacted workers may face a wage offer distribution with a wider variance. For both of these reasons, other things being equal, the expected duration of unemployment for trade-impacted workers is likely to be longer.

Neumann's failure to recognize explicitly this structural difference in the job search relationships for the two groups of workers has probably biased his parameter estimates. In particular, the estimate of the effect of the wage replacement ratio on the average duration of unemployment is likely to be biased upwards, since the trade-impacted workers received a higher wage replacement and were unemployed longer. Some part of this longer unemployment results from being trade impacted and not from the higher replacement ratio. Neumann's methodology fails to control for this.

There is some evidence that Neumann's estimate is in fact upward biased. In a study of the effect of UI benefits on job search behavior using data similar to Neumann's in many respects, Ehrenberg and Oaxaca [2] found that for males aged 45 to 59, an increase in the replacement ratio from 0.4 to 0.5 led to an increase in unemployment duration of 1.5 weeks. Neumann's estimate is that the unemployment of an average male TAA recipient increased in duration between 1.89 and 2.84 weeks. Since the average replacement ratios for non-TAA recipients and TAA recipients in his sample are 0.37 and 0.47, respectively, this implies that a 0.1 increase in the replacement ratio leads to a 1.89 to 2.84 week increase in duration, i.e., a larger effect than indicated by Ehrenberg-Oaxaca's estimate.

It is possible that with the proper control variables Neumann's estimates need not be biased, but I have difficulty conceiving of control variables that would measure differences in wage distribution information and variance. One possibility is a change in the industry of employment from the pre-unemployment to post-unemployment job. Neumann does use a dummy variable indicating whether a change in industry at the 2-digit SIC level occurred. But I question whether this post-unemployment job variable could eliminate all the bias. Another possible control variable would be years of job tenure prior to unemployment. Neumann used such a variable in his wage change equation but not in his duration equations.

Given the lack of adequate control variables, I would suggest a dummy variable indicating receipt or non-receipt of TAA. If such a variable were statistically significant, it would be evidence that (1) trade-impacted workers face a different job search environment as hypothesized above and (2) that genuinely trade-impacted workers have been the ones certified and granted TAA.

The same considerations that would lead Neumann's duration effect estimates to be upward biased would bias his wage change estimates downward.

The Ehrenberg-Oaxaca estimate of the wage change replacement ratio relationship for 45-59-year-old males implies that an increase of 0.1 in the replacement ratio leads to a 7 percent increase in the post-unemployment wage [2]. Neumann's estimate implies that an equivalent rise in the replacement ratio leads to a 4.25 percent increase in the post-unemployment wage. Again, it would be a simple matter for Neumann to include in his regression equations a dummy variable indicating receipt of TAA.

Professor Neumann has provided us with an analysis of an important aspect of international trade policy, for if we are to achieve the expected benefits of more trade we must devise an effective program of compensating those workers who will be hurt and who will be forced to make adjustments. With some revisions, I believe this study could provide useful information about important aspects of the TAA program.

Literature Cited

1. Classen, Kathy. "The Effect of Unemployment Insurance on the Duration of Unemployment and Subsequent Earnings." *Industrial and Labor Relations Review*, in press.
2. Ehrenberg, Ron, and Ron Oaxaca. *Unemployment Insurance, Duration of Unemployment, and Subsequent Wage Gain*. Technical Analysis Paper No. 37. Washington, D.C.: Office of the Assistant Secretary for Policy Evaluation and Research, U.S. Department of Labor, 1975.
3. ______. "Unemployment Insurance, Duration of Unemployment, and Subsequent Wage Gain." *American Economic Review*, 66 (December 1976), 754–66.
4. Holen, Arlene. "Effects of Unemployment Insurance Entitlement on Duration and Job Search Outcome." *Industrial and Labor Relations Review*, in press.

Foreign Trade and U.S. Employment

Murray H. Finley*

My invitation to this conference suggested that I give my "unvarnished" view of the relationship between foreign trade and investment and employment. I was delighted to accept the invitation for two reasons. First, I was pleased to know that at least there were some in government who recognized and acknowledged that there *is* a relationship between foreign trade, investment, and employment. Often it seems to us in the labor movement that many people, both in and out of government, do not accept the relationship and if they do, would prefer to simply sweep this fact under the rug. Most seem to consider it a low-priority problem that can be dealt with at some time in the future—if it has to be dealt with at all.

Secondly, I was pleased to come because I believe that the relationship between foreign trade, investment, and employment is extremely important; that the labor movement has something significant to say that no one else is saying, and that should be heard.

The "unvarnished" message that the labor movement is working hard to get across is simply this:

- That jobs are the fundamental base on which our economic and social well-being rest;
- That no lasting social or economic progress can be made, or political stability maintained, either within the United States or elsewhere in the free world, unless the U.S. economy remains strong. The increasing international interdependence not only means that the United States cannot act in isolation from the rest of the world, but also that our own economic health is essential to the economic and social welfare of the entire international community.
- That there are things happening as a result of our foreign trade policies that are undermining U.S. economic strength—and these things should not go uncorrected. These things include the loss of jobs to imports, the continuing flow of investment capital overseas, and the accelerating transfer of technology without planning or recognition of the impact of such transfers. All of these factors are contributing to the steady shift in this country toward a service-oriented economy rather than a production economy—a shift we believe has serious implications for the future growth of this country.

It sounds glamorous to say we will be engaged in transportation, in communication, in banking, in services. We will be a kind of technological and managerial elite who will send our production offshore, but consume in abundance at home. We supply the computers and the brains; the rest of the world supplies the resources and the brawn. That is, in my judgment, a total misconception about what would happen. If such a service-oriented economy ever did come to its own, there would be a separation between those who don't have the skills to participate in the good life and those who do. A two-class society would develop: an under class and those in the elite who manage the rest of the world.

There are political dangers besides the domestic economic dangers I've mentioned. The high consumption, nonproduction service oriented economy sounds very good at least if you're an elite, but this assumes a peaceful political world. Can we imagine what could happen if we produced no steel, or plastic, or electronics etc., but only managed their production in the rest of the world. Suppose there are expropriations of our investments around the world. We'd be left with an elite with no one to manage around the world.

In our judgment, undermining the industrial base of this country cannot but lead to serious political consequences. We need a strong production oriented economy to maintain our military and political strength. But we also need a strong production oriented economy to provide basic industrial employment.

Now, probably, most of you had already decided what I was going to say today before I started. You probably expect me to say that imports are flooding the country, that American workers are losing their jobs; that something has to be done. I won't disappoint you.

Imports — in many industries, including my own, are flooding the country. Let me cite a few examples.

- In my own industry—textiles and apparel—imports have increased dramatically since 1970. In 1975, the quantity of foreign-made suits entering the domestic market was more than double the 1970 level. Jacket imports were up about 75 percent and trousers imports were higher by 35 percent. The import penetration rate of the domestic market for suits increased from 6.3 percent in 1970 to 9.5 percent in 1975. For coats and jackets, the penetration rate for the same period increased from 16.3 percent to 22.0 percent. For trousers, the rate increased from 7.5 percent to 13.4 percent. The 1976 figures are even more elevated.

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*Mr. Finley, who is President of the Amalgamated Clothing and Textile Workers Union, delivered this speech at the U.S. Department of Labor Conference on the Impact of International Trade and Investment on Employment, December 2, 1976.

- In the specialty steel industry, the story is similar. Imports this year have already increased 12.5 percent over last year. The quotas apparently are already filled. Obviously, imports would go higher without the quotas.
- The shoe industry has been all but destroyed by imports. In the ten-year period 1965–75 imports of shoes and footwear increased 1,000 percent—with a resulting decline in the U.S. domestic industry of more than 30 percent—and it is still going down. Ten years ago, imports accounted for less than 20 percent of domestic consumption—today they make up about half of the total.
- Black and white TVs—the industry has been wiped out by imports—70 percent are imported. This last year, the penetration rate for color TVs has shot up to 35 percent.
- It is not just the labor intensive, consumer goods industries which are affected by imports. Between 1971 and 1975, imports of capital goods increased 132 percent, or almost twice the rate for all manufactured goods.

Workers Are Losing Jobs

The debate over how many jobs have been lost both to imports and foreign investment is not going to be solved here today. But there is no question that jobs have been lost—and that the number stretches into the hundreds of thousands, even millions—depending on when you want to start counting and on what kind of assumptions you make—especially as to what *might* have happened if there had been no foreign investment, and no increase in imports.

But even if we cannot provide irrefutable macro data, there are plenty of micro data to tell the story. It is not only sufficiently convincing to provide a basis for public policy determination, but also represents such serious disruptions in individuals' lives that attention *must* be paid to it. To the hundreds of thousands of individuals who have lost their jobs because of imports, to talk about the broad picture is most unpersuasive.

The caseload data from the International Trade Commission and the Department of Labor provide one indication of the extent of job displacement resulting from our foreign trade policies. Under the 1974 Trade Act, adjustment assistance petitions have been filed for about 435,000 workers. Labor Department figures show that through the first six months of this year more than 160,000 workers had been certified as eligible for assistance. In my own industry—men's and boys' apparel—we know that at least 45,000 workers have already lost their jobs, and the remaining thousands are distinctly uneasy. We filed TAA petitions for close to 50,000 workers and have had eligibility certified for approximately 35,000. And in filing for these 50,000, we used certain arbitrary yardsticks that left out a lot of affected workers. First, a cutoff date of 1974. Second, only cases where unemployment reached 15 percent or more. This is only in our industry alone, and not even the total industry, but basically only tailored clothing, shirts, and some of the outerwear industry.

In the footwear industry, about 80,000 have lost jobs. Just through the first six months of this year, more than 160,000 workers whose jobs were lost to imports have been certified as eligible for TAA. However, none of these figures count those who lost their jobs because of increased foreign investment—when U.S. companies establish new plants overseas rather than here; and serve foreign or even U.S. markets from overseas plants instead of from U.S. plants.

As I mentioned, it is not just the economic problems that concern us—but the very human ones that lie behind all these figures. Let me quote from a letter I received a couple of weeks ago. The letter is from one of our members in New Albany, Indiana. The plant in which she was employed closed a short time ago.

> Mr. President Murray H. Finley, I would like some information on whether and if there is anything that can be done about the imports and the illegal aliens in this country. We at the H.A. Seinsheimers Mens Clothing have been closed down because of imports. Is it fair for us to be out of jobs and isn't there a way to deal with this business through legislation. I hope . . . unemployment pay is nice. But it isn't enough the way prices are and this small town doesn't have many jobs if you are over 40 and besides you can't be paying in on your Social Security. Thank you very much, Mrs. Mary Harris.

I haven't answered this member of ours. I am hoping someone at this conference will provide an answer. But I can't bring myself to answer on the broad, overall picture of trade and a promise that somewhere down the road, adjustments will be made. She is asking, "What can be done?" And she is talking about herself and the 450 other people who have just lost their jobs in New Albany, Indiana.

Something Has to Be Done

All of us here no doubt agree that something has to be done. But many—maybe most—believe that the "liberalized" Trade Adjustment Assistance program fills that bill. It does not. Of course, we intend to make full use of it—because it is there. We have an obligation to do the best we can for members who lose their jobs because of imports. If as a result of the federal legislation they are able to get $1,200 additional dollars as a kind of employment burial pay, we have an obligation to seek it out for them. But it is a band-aid approach when a tourniquet is called for. I am often asked, why isn't TAA enough? Why isn't it a good answer?

There are two reasons why not:

- It doesn't get to the root of the problem, and
- TAA doesn't work—it is not effective in helping the individuals who need help.

Let me talk about the second point—the kind of help actually received by workers displaced by imports. There are at least 435,000 workers on whose behalf petitions for assistance have been filed since enactment of the Trade Act. Of these, only 160,000 workers have been certified as eligible. Of these, only 106,000 have managed to make their way through the maze of regulation and procedure and have actually applied for assistance. Of these, only 58,000 had received any payments by last June, 1975. So only about one in eight has actually been helped. And what help they get is minimal. Through June 1976, they had received an average of about $1,200 apiece. Only 24 workers had received financial job search assistance and only 23 workers received relocation assistance. This is out of at least 435,000 workers on whose behalf petitions have been filed. It is in fact a band-aid program, and a small one at that!

We made a study to see what happens once the petitions are approved and eligibility certified. And I will tell you, it is a maze. We had a situation in Illinois where a large plant closed with about 500 workers. They were certified as eligible, but far from automatically. It was impossible simply to go to the various employment service field offices, most of which didn't even know how to handle petitions for trade adjustment assistance. They just were not trained to do it. We ended up almost desperately writing to the governor, the secretary of labor, I think, to President Ford and possibly President-elect Carter. And this was not, by the way, an unusual case. We generally have to fight for the workers' certification.

We know some 35,000 have been certified in our industry. But we can't even tell you how many got trade adjustment assistance nor how much. We know some did. But we don't know how to find out the full story. There is no mechanism to notify workers potentially eligible for TAA to get them to the employment office to get the money. This, by the way, may be a year after they were laid off as a result of the impact of imports. While money, when it comes, is always welcome to an unemployed worker, it obviously does not handle the problem that it was meant to handle, that is to get them into new jobs.

A study of adjustment assistance in the shoe industry as reported in the Monthly Labor Review bears this out [1]. The study found that only one of the sample of 185 workers who were laid off had participated in a government training program, only one had received a relocation allowance, and only five had been placed in jobs through the efforts of the local state employment service agency — in this case the Massachusetts employment service. One-fourth of those laid off never found another job. Half were not employed full time, and real wages for those who were employed had declined almost 18 percent from prelayoff levels.

The report also found that workers waited an average 19.4 months between the date of layoff and the receipt of their first TRA check. That this long delay is typical is substantiated by numerous reports from my own union. Our field people report "horrendous red-tape" involved in getting help to our members from the state employment service agencies. In Illinois, for example, the state employment service simply failed to do the job it was supposed to do — and this despite repeated meetings with state personnel, and repeated reassurances that the problems with local offices had been corrected. In our view, the time lags between application and receipt of benefits are inexcusable.

One "safeguard" supposedly built into the Trade Reform Act was the advisory committees through which the labor movement and other affected groups could participate in all aspects of foreign trade policy development. The idea was that through the advisory committees, constituent problems could either be quickly resolved or avoided in the first place. I and other officers of our union are members of the Advisory Committee for Trade Negotiations, the Labor Policy Advisory Committee, and the labor sector of the Advisory Committee for Textile Apparel and Leather Products. Meetings have certainly been held and we have participated; even presented detailed positions on specific problems facing workers in our industry. But these meetings have been designed more to brief us on the issues that will arise in the multilateral negotiations to take place in Geneva, not to get our advice or to resolve problems, What I sense is happening is that the meetings are being carefully orchestrated so that most of the time is spent on being briefed. What little time is spent on advising is to no avail because the negotiators ignore the advice — and, in fact, had already developed predetermined positions before the advice was given. Thus, instead of a safeguard, to assure that trade policy is consistent with national interests and goals, I and many of my colleagues feel that we are engaged in a charade — designed merely to meet the literal requirements of the Trade Act. But the Labor Policy Advisory Committee is not in any real sense *advisory*.

Now to go back to the first point — that TAA simply does not get to the roots of the problem. Adjustment assistance is based on the premise that so-called free trade provides benefits to all of us, and that the cost of these benefits should not be borne unequally by the few who suffer immediate (but supposedly temporary) injury, but should be spread among all taxpayers. We in the labor movement have learned to our sorrow that this premise, and the presumptions underlying the program, are wrong.

First, we don't have a free trade situation or anything approaching it in the world today — if indeed we ever did. The United States may or may not be operating on a free trade basis, depending on how loosely you want to define it. But we are alone among the trading nations in acting as if the free trade concept were fact and not fancy. Such common phenomena as administered prices, nontariff barriers, local content laws, preferential trading agreements, and subsidized exports make a mockery of "free trade." The labor movement expects U.S. policy to start from a recognition of things as they are — not from an imaginary world, as we might like it to be.

Second, and most important — U.S. policy, particularly foreign trade policy — must become the natural outgrowth of national economic policy. Foreign trade questions, foreign investment issues cannot be resolved or even considered apart from domestic economic concerns. Our foreign trade and investment policy must be an adjunct of national economic policy — they must serve *national* needs — not the other way around. Let me briefly sketch the picture as we see it.

On the Home Front

There can be no question that the United States is the strongest nation in the free world. I am speaking here in economic terms. There is nothing chauvinistic in recognition of the fact that we have more resources, and use them better, than any other nation. Our resources — skilled labor, capital, technology, management capability, natural wealth, climate, and social organization — all combine to make us the strongest economic unit. Yet at the present time our economy is in trouble — teetering on the brink of recovery — and I say that advisedly.

- There are almost 8 million American workers unemployed consisting a festering sore on the economy, a severe drain on the federal budget (about $17 billion this year), and a drag on GNP growth. This is not to mention the individual hardship that the unemployed incur.
- We are told that an insufficient amount of capital investment is being made to create the new jobs that must be created in order to reduce unemployment.
- We read of potential shortages both of essential raw materials and of production capacity to convert these basic materials for our industries. Shortages are forecast in such basic industries as aluminum, copper, lead, and zinc.
- The wholesale price index has been rising steadily over the year and in the past few months, fairly sharply, signaling an increase in the rate of inflation in the very near future.

There has been a long-term decline in the average rate of productivity growth—which not only affects the U.S. ability to compete in world markets but also means a slower rate of improvement in the average worker's standard of living. Between 1948 and 1966, productivity in the United States increased each year at an average rate of 2.4 percent. But between 1966 and 1973, the average rate of productivity increase dropped to only 1.7 percent. This decline in productivity growth occurred at the same time that there has been a gradual shift of the economy from the goods producing sector to the service sector; and this really worries us.

Twenty-five years ago, only 30 percent of the GNP was attributable to the service sector of the economy and almost 60 percent to the goods producing sector. Since that time there has been a steady increase in the service sector and a steady decline in the goods producing sector. Last year, the two sectors were about even — but clearly the service sector has the forward momentum.

In our view there is a connection between these two developments — the decline in productivity growth and the trend toward a service oriented economy. Since technology is more readily applied to manufacturing — to the production of goods — than it is to the provision of services, it is in this area that the greatest improvements in productivity can be made. And without productivity growth, there can be no improvement in the general standard of living. We all here today may be surfeited with material goods, and maybe our college educated, middle class children are ready to spurn materialistic things, and return to the "simple life." But let me remind you that the 26 million citizens whose income is below the poverty level are not ready to give up on improving their material and physical well being. Nor, I venture to say, are the tens of millions more whose income currently falls somewhere between the $5,500 poverty level and the $14,000 median family income. They are already savoring the simple life. And they don't like it. Improvements in the general standard of living — and therefore in productivity — are not only viable goals, they are still very fundamental goals.

So here we have the U.S. economy — the keystone of the world economy — the rock on which the free world economy *must* depend – and there are ominous signs that the rock is turning to sand.

The Picture Outside the U.S.

What is happening in the rest of the world? In the developed countries, the pace of recovery is no better than in the United States, and in many it is even worse. Great Britain's situation is almost desperate. I can only say as an aside, if we looked at the history of what we are doing with direct foreign investment, and what Britain did in the 1800s and 1890s, in terms of portfolio investment, becoming a Rentier economy, we are going on the same road and unless we turn it around, in my judgment, we will end up with the same dire results. Italy is also in a bad way. France, with rising inflation and in serious trouble. Even Japan has an inflation rate considerably higher than our own, and its recovery is faltering, if not actually stopped. Only West Germany is doing well. The situation is worse when we look at the developing countries — except the OPEC which, of course, are doing very nicely. Many of the developing countries, dependent as they are on exports of raw materials to buy the goods they need for development, and sometimes simply to maintain a subsistence standard of living for their people, are seeking ways to parlay their control over raw material resources into greater benefits and returns for themselves.

The newly established cartels — of which the bauxite producers' association is probably the most successful — the demands for a new International Economic Order for debt repayment deferments, for special trade preferences, and for U.S. financing of price stabilizing buffer stocks — all of these efforts are indicative of the basic economic insecurity of these nations. The success of these nations in improving their economic and social well-being is completely dependent on a healthy world economy — and the world economy cannot prosper without a strong, growing U.S. economy. If the U.S. economy fails; if our recovery falters and we slide into another recession, which is the way the signs are pointing at the moment, the free world economy may come down like a house of cards. That is why it is so important to pay attention first and foremost to what is happening in the United States. And that is why it is so important to pay attention to what is happening to U.S. employment — to jobs that are the base on which the economy stands.

Let us look for a moment to what is happening in foreign trade and investment.

U.S. Foreign Trade and Investment Trends

Perhaps the most significant international development in the past ten to fifteen years is the rise of the multinational corporation and the spread of U.S. capital and technology throughout the world. In 1975, the value of U.S. direct investment abroad was two and half times as much as it was ten years before, increasing from $52 billion to more than $133 billion. Annual expenditures for plant and equipment by majority owned affiliates of U.S. companies abroad trebled in 10 years, increasing from $8.6 billion in 1966 to an expected $27.1 billion this year. And there is no end in sight. At the same time that this capital is going out of the country, we are told that we are facing a capital shortage in the United States.

We are also told, don't worry; foreign investment is good for the U.S. economy. Foreign investment, it is said, creates jobs. It brings in more money than flows out. And besides, we are told, even if some workers lose their jobs, other jobs will quickly become available. I don't believe it!

- If that were really so, then how can you account for the fact that the Commerce Department survey of 298 multinational corporations showed that overall employment in their foreign affiliates grew by 26.5 percent between 1966 and 1970, whereas employment in these companies' domestic plants grew by only 5.7 percent — less than a quarter of the rate of increase of employment overseas? Where is the job creation here? Or what accounts for the fact that production worker employment increased 14.5 percent faster for the MNCs overseas than for the U.S. domestic plants?
- If it were true, how can you account for the fact that balance-of-payments income from direct investment declined by 47 percent in 1975? Last year income was only $9.5 billion, considerably less than the $13.4 billion that was added to the book value of direct investment that year.
- If it were true that other jobs are going to become available, how can you account for the stubbornly high unemployment rate — almost 8 percent — which at the moment seems to be going up, not down?

We have been told that one of our international obligations is to recognize the need of developing countries to industrialize and to obtain a larger share of the world trade. We don't disagree. But the point I want to make here is that this will not be done unless the U.S. economy is strong. There will be no problem in improving the terms of trade for developing countries, or increasing their share of the world's economic pie, if the pie itself is bigger. We are also told that we should trust the market mechanism; that left alone everything will come out all right. All I can say on that is, we cannot afford to simply let things happen, on the theory that the market is the best arbiter and most efficient allocator of resources. The fact is that the market doesn't work very well. For example, there was no sense in the Russian grain deal which eliminated the U.S. grain surplus, led to tight supplies and set off a furious round of inflation. There is no sense in closing down plants here, as we are in the case of aluminum, simply to open up new ones overseas, and at the same time paying higher prices for the aluminum we need, when for the same price we could develop substitute sources of aluminum in the United States, and keep the jobs in the United States. It makes no sense to continue to keep millions of American workers on an unproductive income maintenance program, and at the same time, through discriminatory tax incentives, encourage U.S. companies not only to go overseas but to increase their capital expenditures overseas.

What we have to decide is where we want to go, where we want to be, and then do the things that are necessary to get there. The first step obviously is a full employment policy, a domestic program that through a carefully planned, integrated program brings us to full employment within the next four years.

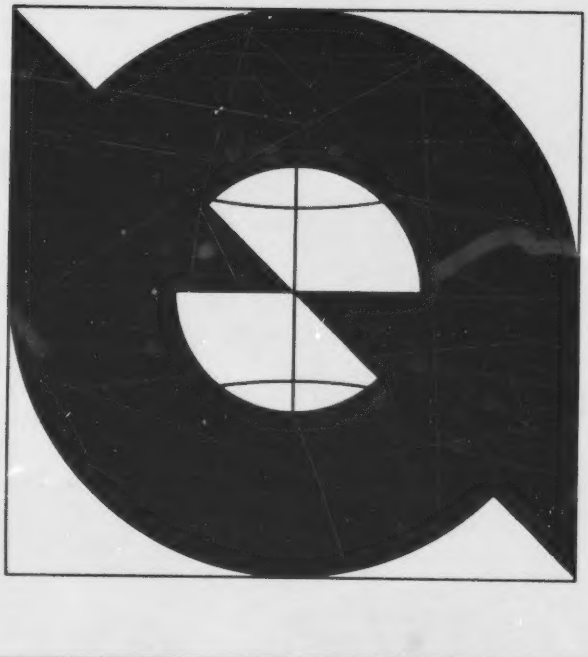
The second step is to stop doing the things that interfere with the goal of full employment. High on the list is the development of a foreign trade policy that is firmly based on and completely consistent with national economic and social policy. Not the kind of backward nod in the direction of national goals that is epitomized by the trade adjustment assistance program. But a forward-looking program where such ineffectual artifices are not necessary and are not even considered.

Literature Cited

1. McCarthy, James E. "Contrasting Experiences with Trade Adjustment Assistance." *Monthly Labor Review*, 6 (June 1975), 25–30.

Part Four

Foreign Investment and Technology Transfer



Introduction

Gary C. Hufbauer*

The papers by Horst, Frank and Freeman, and Baranson make a contribution to the economic analysis of direct foreign investment. These studies might well serve as references both in the conceptualization of issues and in the application of techniques. At the same time, the papers usefully illuminate points of agreement and disagreement. The studies are rich in findings and analysis; but my introductory comments will necessarily be confined to a few themes.

Horst

In his paper, "The Impact of American Investment Abroad on U.S. Exports, Imports and Employment," Horst is concerned with measuring the net effect of whatever relationships exist between U.S. investment abroad and U.S. trade. Reviewing the microeconomic debate, Horst is a persuaded agnostic. Foreign investment may either complement or substitute for domestic investment. Investment abroad by American firms may either flow passively in response to the compelling policies of foreign governments, or it may result from an active search by U.S. firms for new opportunities. Once located in foreign markets, American companies may either pull large amounts of U.S. exports with them or on balance they may substitute foreign production for U.S. exports.

Horst's contribution is to assess the net result of these opposing forces. Using a model that controls for other influences, he measures the impact of foreign investment on U.S. exports and imports, industry by industry. On the whole, Horst finds no strong statistical relationship, positive or negative, between U.S. direct investment and U.S. trade performance.

Commentators at polar ends of the foreign investment debate have argued that production by U.S. subsidiaries abroad either materially assists or badly erodes U.S. exports. The absence of a strong statistical relationship is thus highly significant. It implies that, contrary to accepted belief, the complementary and substitute forces are about equally balanced. A low threshold of foreign investment may promote exports; beyond that threshold level, Horst finds that the connection varies from industry to industry. Consequently, if a U.S. policy towards foreign investment were designed to promote exports, that policy would necessarily be "selective" in order to be efficient. The policy would have to discriminate between industries, and possibly between countries. This presents a dilemma, for not only would it strain the capability of government bureaucracy to favor the right industry in the right place at the right time, but also such an approach would contradict established precepts of neutrality, reflected both in international trade agreements and in national tax laws.

Frank and Freeman

Frank and Freeman examine "The Distributional Consequences of Direct Foreign Investment." Their analysis contemplates a significant degree of substitution between investment abroad by U.S. enterprises and investment at home. Based on this premise, Frank and Freeman carry out a step-by-step analysis of the consequences of U.S. foreign investment for: (a) U.S. employment by skill category; (b) implied adjustments in U.S. relative wage rates necessary to restore full employment; and (c) the level of real national income.

According to Frank and Freeman, the initial impact of foreign investment falls most heavily on lower skill groups. These groups traditionally experience the highest rates of unemployment, and thus Frank and Freeman see foreign direct investment as worsening the bottlenecks that already exist in the labor market. Further, as the adjustment mechanisms come into play, the initial employment impact would be translated into lower relative wages for blue collar groups. Finally, because foreign governments collect nearly all the tax revenues on U.S. investment abroad, a net shift of that investment back to the United States would increase U.S. real national income.

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*The opinions expressed represent the views of the author, not the views of the Treasury Department.

The estimated employment impacts are very sensitive to the substitution parameters. Frank and Freeman report that their best estimate of the initial employment loss attributable to plant and equipment expenditures by foreign subsidiaries of U.S. firms in the year 1970 was 160,000 jobs. This estimate drops to 20,000 jobs if the substitution parameters are half as large as the preferred estimates, and rises to 440,000 jobs if the substitution parameters are twice as large.

The Frank and Freeman results depend on two assumptions concerning world capital markets: first, that sufficient friction either exists in the world economic system, or can be created by government action, to ensure that rates of return on capital differ between the United States and other countries; and second, that foreign governments would not retaliate against a policy-inspired reduction in the investment expenditures of U.S. subsidiaries abroad.

Baranson

In "Technology Transfer: Effects on U.S. Competitiveness and Employment," Baranson summarizes some twenty-five case examples—drawn from the aircraft, automotive, computer, consumer electronics, and chemical engineering industries—of technology transfer by U.S. firms to independent foreign companies.

Baranson finds a variety of motives underlying the release of proprietary technology. In one case, the acute capital needs of a small U.S. computer firm explained the transfer. In other cases, the technology was no longer central to the American company's business. The atmosphere of detente was part of the bargain in Eastern Europe. In other situations, the risks associated with tangible investment were too great, and companies saw the license of technology as the only feasible method of participation in foreign markets.

In twenty of Baranson's twenty-five cases, alternative Western firms had competitive technology, and this contributed to a bandwagon mentality on the part of U.S. firms. In addition, foreign governments often made coordinated use of policy instruments to improve their bargaining power. In Baranson's view, the inevitable result was a reduced financial return for American technology and increased competition in the production of goods for American firms. Again, the implication for U.S. policy is that countervailing restrictions would have to be selective to be effective. Those familiar with the work of the North Atlantic Treaty Organization's International Export Control Coordinating Committee (CoCom) realize the difficulty of implementing selective restrictions on the international transfer of technology.

Agreement and Disagreement

From these three papers, it is possible to distill certain major points of agreement and disagreement. To begin with, direct investment and technology transfer policies must be grounded on microeconomic considerations; such policies are likely not an effective vehicle for reaching macroeconomic goals.

A major point of disagreement is the extent of substitution between investment at home and investment abroad. In the past, the debate has focused on physical capital, but, as Baranson points out, the same questions arise in the context of new production technology. The extent of substitution is a critical issue; virtually everything in the foreign investment debate hinges on this highly sensitive parameter.

Finally, U.S. involvement in world markets, both through trade and investment, enhances the demand for skilled American labor, and possibly increases the returns to U.S. capital while reducing the demand for unskilled American labor. Building on this observation, one school of thought views an open economy as a device for stimulating the acquisition of human skills and the accumulation of physical capital in the United States. By contrast, another school views an open economy as attacking the economic interests of the weakest segment of American society. The formulation of international economic policy in the years ahead will in part depend on which school prevails.

The Impact of American Investments Abroad On U.S. Exports, Imports and Employment

Thomas Horst*

Introduction

When American manufacturers invest abroad, do they displace American exports and with them American jobs? When they establish plants in Mexico or South Korea and export back to the United States, do they add to the flood of American imports and leave more Americans unemployed? Or are they merely riding a tide of economic change that they have neither initiated nor controlled? Indeed, could it be that American multinationals through their foreign operations promote U.S. exports and/or minimize U.S. imports? Of all the questions raised by U.S. investments abroad, few have provoked as extended and as acrimonious a public debate as these.

Although many international economists have employed general equilibrium analysis to the relationship between international trade and investment, the public policy debate and our own analysis has focused largely on the microeconomics of foreign investment behavior. In a general-equilibrium model of perfect competition, the atomistic firm can invest as much of its capital abroad as it wants without worrying about the impact of its own exports or imports; any relationship between international trade, investment, and employment derives from the aggregate conditions for a general economic equilibrium.

By contrast, the labor unions have largely ignored the general equilibrium issues and focused instead on the impact of a firm's foreign investment on its own exports and imports. Likewise, the multinationals in countering labor's charges have accepted the microeconomic framework, but argued that the effects on U.S. employment are positive, rather than negative. Although economists are hardly obligated to respond to important public policy issues on the narrow terms they are often posed, the very nature of the debate suggests that there may be important microeconomic issues that have been overlooked by general-equilibrium analysts.

1. The Microeconomics of Foreign Investment Behavior

Most microeconomic models of foreign investment behavior suggest that foreign investment substitutes for domestic U.S. production and employment. This substitutional relationship may arise in two ways, the first being that the multinational may have limited funds available for domestic or foreign investment. Most economists are uncomfortable with this supposition, since it implies that the firm cannot raise new capital at the going rate of interest. A second possibility is that *product* markets, rather than *capital* markets, constrain the manufacturer's new investment. The typical investor manufactures a product different from that of its competitors. Maybe the firm has a secret formula, a patent protecting a superior product or process, or a better reputation with its customers than its competitors do. When IBM decides to build *its* computers in Europe, or RCA to build *its* television sets in the Far East, U.S. employment falls because no other American producer has the rights to use these companies' patents, trademarks, distribution and service facilities, and so forth. This latter supposition, that the multinationals' products are less than perfect substitutes for one another, has been amply documented by analysts of foreign investment behavior.

But although most microeconomic theory emphasizes factors affecting the location of production, a modern American corporation is much more than a manufacturer in the narrow sense of the term. The corporation recruits and trains workers and managers, researches and develops new products, seeks out new customers through advertising and direct selling methods, finances and distributes its product, provides technical assistance to users, and maintains repair, service, and spare-parts facilities for old customers. The

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literature on foreign investment behavior is replete with testimonials to the importance of these activities in maintaining and expanding markets at home and abroad. Recognition of these "ancillary" activities is critical because the foreign investment statistics we compare to U.S. exports and imports often include these nonmanufacturing endeavors, and because public policy towards foreign investment rarely discriminates between manufacturing and nonmanufacturing activities. For instance, the balance of payments guidelines of 1965–74 or various aspects of U.S. tax policy make no distinction among these different types of foreign investment activity. If microeconomic theory is to be of real assistance in interpreting foreign trade and investment statistics or in formulating new policy towards foreign investment behavior, the theory must be broad enough to encompass manufacturing and nonmanufacturing activities.

To show the importance of this distinction and to bring out other points, let us briefly analyze a multinational's decision to establish a foreign manufacturing plant to supply an erstwhile export market and then contrast that type of investment with other activities. For the time being, we will make the conventional assumption that the foreign market for the firm's product is fixed and given (in the sense that there is a downward-sloping demand curve), so that the decision to produce abroad is also a decision not to export.

If the foreign market for American goods is thus limited, what determines the choice between exporting and overseas production? Some American firms may be very conservative about investing abroad, especially if they have had little experience operating overseas, and they will continue to export as long as they can maintain a reasonable market share from an American base. Since American wage rates until recently have been higher than those in Canada or Western Europe, to say nothing of Latin America and other developing areas, the American firm would have to face low tariffs, transport costs, and other barriers to exporting *and* have either a distinctive product or enjoy some significant cost advantage for exporting to be feasible. Such cost economies might come from the economies of large-scale operation or the experience embodied in a highly skilled and experienced labor force. We have considerable empirical evidence that U.S. manufacturing exports are highly concentrated in industries employing more scientists, engineers, and other highly skilled labor than is typical in U.S. manufacturing as a whole.

Foreign production saves on tariffs and transport costs and allows the American firms to tap cheaper foreign labor, but it has its drawbacks as well. In particular, investors often encounter substantial start-up and overhead costs in establishing foreign plants. Although the American firm may be able to export using existing U.S. plant capacity, especially in periods of slack domestic demand, foreign production may compel additional property, plant, and equipment expenditures that exporting does not. More importantly, if less tangibly, foreign production may bring a host of hidden learning costs as the investor learns the ropes of labor relations and trains a foreign work force. If these start-up costs are too imposing, foreign production may simply not be worth the effort. We have considerable evidence from various case studies that U.S. investors are more willing to consider foreign production should exporting become difficult when it has already spent much time, effort, and money establishing its name with foreign customers, when the foreign market is large or looks like it will grow quickly, or when the American investor has had experience in other countries in setting up foreign operations.

An American firm's decision to replace its own exports may be precipitated by several factors: (1) an increase in the tariff on its exports, (2) a wide variety of other pressures and incentives by host countries to undertake local production, (3) inflation in U.S. labor and material costs relative to those overseas, (4) a devaluation of the foreign currency against the dollar, (5) growing competition in the foreign market forcing it to utilize cheaper foreign production, (6) growth of the foreign market to a point where foreign start-up and overhead costs no longer loom so large, or (7) the firm's own seemingly gratuitous reassessment of the pros and cons of investing overseas. In each of these cases, foreign production will expand and U.S. exports contract. Given a limit on how much the firm can sell abroad, more foreign production is bound to mean less exporting, whatever the reason for the substitution.

But it is important to note that even when the relationship between American and foreign production is purely substitutional, we have no simple answer to the critical issue of what would have happened if the American firm did not or could not invest abroad. The answer depends in large part on what factor or factors precipitated the foreign investment. In some cases, such as higher tariffs or other new barriers to exporting, inflation of U.S. wage rates, devaluation of the foreign currency, or an increase in local competition, the alternative to foreign production may be either a reduction in U.S. exports or total withdrawal from the foreign market. In other cases, however, such as the growth of the foreign market (unaccompanied by an increase in foreign competition) or the seemingly gratuitous reassessment of the benefits of investing abroad, U.S. exports might be maintained or even expanded. Much of the controversy over what would have happened if American firms had not invested abroad (the continued-exporting hypothesis versus the other-firms-would-have hypothesis) would seem to be a debate over what sorts of factors typically precipitate the decision to invest overseas.

The case of a foreign subsidiary exporting back to the United States — the runaway shop — can easily be integrated into the type of analysis outlined above. American production and employment benefits not only from the economic and psychological inertia of the status quo — why close an American plant as long as it is competitive — but also from tariffs, transport costs, shipping delays and all the other barriers to trade that hurt U.S. exports. For an American firm to shut down domestic operations and produce overseas, these trade barriers would have to be low and/or the differential in labor costs high. Highly standardized products requiring a large input of low-skilled labor, such as shoes, electronic components, small appliances, or textiles, are primary candidates for this type of foreign investment. And since American firms are more likely to undertake these investments when threatened with outright losses rather than foregone profits, competition from foreign producers is often a spur to this type of investment. But, in theory at least, this type of investment could be precipitated by a variety of initiating forces: (1) U.S. tariff reductions, (2) explicit or implicit subsidies offered by foreign countries, (3) inflation of U.S. labor and material costs relative to those overseas, (4) a revaluation of the U.S. dollar against foreign currencies, (5) increasing competitive pressure from foreign or other American producers, or (6) a seemingly gratuitous reassessment of the advantages of producing overseas. And here, as before, we must know which of these factors initiated an investment before we can hope to determine what would have happened if the investment could not or had not been undertaken.

One final note before turning to other types of foreign investment. In looking at foreign versus domestic production, there is a natural tendency to emphasize those cases where the two are or recently were both viable alternatives. In actual practice, of course, American production is often a remote and distant alternative to foreign investment. Only a drastic change in tariffs and transport costs, wage rate differentials, and so forth, would induce a multinational firm to relocate its production. The potential substitution of foreign for domestic employment often is more a theoretical possibility than an economic reality.

As noted above, all foreign investment activity is not manufacturing in the narrow sense of the term. Our foreign investment statistics, including those measuring the activities of "manufacturing" affiliates, typically include a wide variety of nonmanufacturing efforts. By any standard other than the composition of value-added or total expenditures, the manufacturing may be the ancillary phase. Comparing U.S. exports or imports to total production or sales by manufacturing subsidiaries is like comparing a basket of apples to a basket of apples, oranges, mangoes, and bananas. The absence of more precise statistics may force us to make such comparisons, but we should at least be aware of the pitfalls of relying on such heterogeneous data.

Rather than discuss the full spectrum of nonmanufacturing activities, let us focus on one particularly concrete example—wholesale distribution—and then try to generalize our conclusions. The distribution of products from a manufacturer to retailers or final users is usually subject to substantial overhead and low variable costs. The economies of size come from various indivisibilities in the construction and operation of warehouses, automation in the handling of inventory, the scheduling and routing of deliveries, and the training of the sales force. An independent wholesaler or distributor keeps his costs and charges down by handling the products of several manufacturers simultaneously. Although a manufacturer will often insist that a distributor not handle any directly competing product lines, the independent wholesaler is rarely dependent on any one manufacturer for his livelihood. The seemingly inevitable consequence is that the independent distributor is less anxious about the success of a product line than its manufacturer is. Although the manufacturer can try to negotiate a contract with the distributor requiring satisfactory performance, deficient effort is difficult to anticipate, difficult to detect, and often difficult to remedy. A distribution contract, like all others, is essentially a license to sue.

The obvious alternative to relying on uncertain independent distributors is to own and thereby control the distribution network. With one's own sales and deliverymen in the field, quick delivery of undamaged goods can be better assured. Important information about new customers or new markets can be more faithfully and accurately communicated back to the manufacturer; buyer reactions to new products can be quickly assessed. The drawback to owning the distribution network, of course, is that all those overhead costs that were implicitly shared by several manufacturers now fall on the one firm alone. Within the United States, we see how American corporations with fragile or perishable products are more ready to undertake their own distribution than others are and that larger firms are more likely to do so than smaller firms are. Likewise, we have considerable evidence that exporters, U.S. and foreign, will undertake more and more responsibility for foreign distribution the larger the potential foreign market for their product is.

Much the same could be said of an American manufacturer's willingness to employ and train its own salesmen, to provide maintenance, repair, and spare-parts facilities, to adapt its product to local specifications, or to provide technical assistance to its customers. These requirements obviously vary substantially from one industry to another (e.g., durables versus nondurables, new products versus old ones, producer goods versus consumer goods, and so forth). The critical difference between all these market-oriented activities and the manufacturing operations considered above is that the former expand the foreign market for American products and the latter affect the location of production and employment. The one may promote U.S. exports (because of the economies of scale and other complementarities between manufacturing and nonmanufacturing activities, increased marketing effort may encourage local production), and the latter surely does not.

Falling between the two extremes of simple manufacturing and the market-expanding activities are assembly operations. When an American investor establishes a subsidiary to assemble U.S. components for local sales, U.S. exports of finished goods may be displaced, but U.S. exports of component parts or machinery enhanced. In theory, and perhaps in practice, the net impact on total U.S. exports could be positive. If U.S. parts and components are being assembled abroad for export back to the United States — the factories across the Rio Grande in Mexico are the most obvious example — the impact on U.S. production and employment is once again ambiguous a priori. Thus, assembly operations provide a mixture of the export displacement we associate with pure manufacturing and the complementarities we have identified in market-oriented activities.

The heterogeneity of American investments abroad is critical both for understanding why statistical analyses usually come to ambiguous conclusions about the net impact of foreign investment on U.S. trade and employment, as ours does below, and to formulating public policy towards foreign investment behavior. With both substitutional and complementary forces at work, foreign investment in the aggregate may simultaneously promote and displace U.S. production and employment. Likewise, a policy that discourages all types of foreign investment — as the balance-of-payments guidelines might have done had they been more stringent, or fundamental changes in U.S. tax policy would, if implemented — is apt to have an ambiguous outcome. The impact depends on the type of investment (manufacturing, distribution, assembly, and so forth) and the reason that the investment is undertaken (higher tariffs, growing foreign competition, expansion of foreign markets, and so forth). Sometimes the impact would be positive, sometimes negative, and often it would be nil. So, although microeconomic theory can shed some welcome light on the relationship between international trade and investment, it cannot and should not lead to simplistic conclusions about the nature of that relationship.

2. Cross-Sectional Empirical Results

Both the microeconomic theory outlined above and the case-study literature on foreign investment behavior preclude our drawing any strong inferences about the impact of foreign investment on U.S. exports, imports, or employment. For public policy purposes one would like to estimate empirically the structural parameters of a fully specified model of multinational firm behavior in order to determine what would happen if U.S. policy were changed in a variety of possible ways. Frank and Freeman [1] have shown how one can utilize information about tariffs and transport costs, wage rate differentials, and so forth. We believe that this approach is useful as far as it goes, but its primary limitation is that it does not go far enough. Their procedure is to take foreign markets for U.S. products as given and focus only on the location of production. Unfortunately, it is virtually impossible to supplement their analysis by developing comparable estimates of the important parameters of investors' market-oriented activities. How does one quantify the cost of gaining information about foreign market opportunities, of developing sales and service facilities, of adapting products to local market conditions, or of establishing a brand name through advertising? The dilemma is clear — a partially specified model focusing only on the location of production oversimplifies and prejudges the relationship between foreign and domestic investment, but a fully specified model does not lend itself to empirical verification.

Faced with this dilemma, we have been reduced to looking at the de facto relationship between American industries' foreign investment on the one hand and their exports and imports on the other. Do industries that have invested more abroad tend to export more or import less than those that have not? This exercise is analogous to tracing the statistical relationship between the price of a commodity and the quantity bought and sold. One cannot interpret a positive relationship as a supply curve or a negative relationship as a demand curve, nor could one infer from that analysis what would have happened if, for example, a tax were imposed on output. One may be able to infer, however, whether the market was fluctuating because of disturbances in supply or demand. A consistent tendency of the price to rise as the quantity fell would indicate that supply was less stable than demand. In looking at the statistical relationship between foreign investment and U.S. exports, a consistent tendency for the one to rise as the other fell would indicate that substitutional factors — such as tariffs, transport costs, and exchange rates — were more volatile than the complementary factors — such as market growth and the development of foreign marketing facilities. Such results cannot be used to determine what would happen if U.S. policy were changed, but they may at least indicate the historical significance of various economic factors. Of course, if both substitutional and complementary factors have been equally significant or insignificant, the statistical relationship will be largely random.

Our empirical analysis is based on a cross section of seventy-five manufacturing industries over the seven-year interval 1965–71. This was, of course, a period of stagnating U.S. exports and surging U.S. imports during which U.S. labor turned away from its liberal attitude towards foreign trade and investment and began pushing the Burke-Hartke Bill. Our primary statistical source is the U.S. Internal Revenue Service, *Sourcebook of Statistics on Income–Corporations*, which presents data drawn from corporations' income tax returns. We have relied on this source rather than the more familiar Department of Commerce statistics because the former are collected annually and offer far more industry detail.

The real and immediate liability of the I.R.S. statistics is that the foreign investment activities of U.S. corporations must be inferred from the levels of foreign dividends and tax credits. Although data on the sales or assets of foreign affiliates of U.S. corporations would have been preferable, they are unavailable. Our proxy for firms' foreign investment levels is their foreign subsidiaries' dividends plus their foreign tax credits deflated by the total assets of the U.S. parents (which includes the book value of the parents' investment in overseas subsidiaries). Conceptually, our foreign investment proxy is so riddled with distortions and errors as to be almost unworthy of further consideration. In actual practice, however, it does not appear to be so bad a proxy.

In Table 1, we have ranked our seventy-five industries according to the average value of our foreign investment proxy over the seven years 1965–71. As one can see, the top industries (toiletries, drugs, soft drinks, computers and office machinery, and photographic equipment and supplies) are indeed those led by the larger American multinationals (Procter and Gamble, Eli Lilly, Coca-Cola, IBM, and Eastman Kodak). Likewise, the clothing, furniture, and wood industries at the bottom of the table consist of many small firms, few of which have national, much less multinational, operations. Although our proxy is probably biased toward the highly profitable, highly advertised products and against the less profitable, more mature products (e.g., rubber products, farm machinery, and metal cans), it seems to work surprisingly well despite its unavoidable deficiencies.

If the AFL-CIO and others emphasizing the substitution of foreign for domestic investment were substantially correct in their characterization of foreign investment, then industries investing more abroad should exhibit lower exports and/or higher imports than industries investing less. In fairness to their hypothesis, we should take account of spurious differences among manufacturing industries. American investors who for one reason or another enjoy substantial technological advantages over their foreign competitors may simultaneously export more and invest more than firms using more traditional technology, but to credit their superior export performance to their foreign investment would be inappropriate. Accordingly, we need to match our foreign investment statistics not only with export and import statistics, but also with information about industries' technological levels and other factors facilitating foreign expansion.

We have gone to Department of Commerce publications to gather export, import, and domestic shipments statistics by the detailed Standard Industrial Classification and matched those statistics as best we could with the Standard Enterprise Classification used by the Internal Revenue Service. Our measure of an industry's export or import performance is the ratio of its exports or imports to comparable domestic shipments. The value of exports and imports as a percentage of domestic shipments averaged over the seven years 1965–71 are shown in the fourth and fifth columns of Table 1. One can see, for instance, that over this seven-year period toiletry exports averaged 1.9 percent of domestic shipments, and toiletry imports (perhaps, but not necessarily, from overseas affiliates of U.S. corporations) averaged 0.3 percent of domestic shipments. We are also interested in the growth of exports and imports over this period, which we have measured by the increase in the average ratio between 1965–67 and 1969–71. Referring to the sixth and seventh columns of Table 1, we see that toiletry exports as a percentage of domestic shipments declined by 0.1 percentage points between 1965–67 and 1969–71, and toiletry imports increased by 0.1 percentage points. Finally, the eighth and ninth columns show industries' employment of scientists and engineers as a percentage of total employment in 1970 (a conventional measure of technological sophistication) and the industries' advertising expenditures as a percentage of total assets (a conventional measure of advertising intensity). As one can see, the high technology and high advertising industries have a high foreign investment proxy. Because this same correlation has been amply documented by researchers using foreign investment measures conceptually superior to our own, we gain additional faith in our proxy.

Industries' export performance can be analyzed by cross-tabulations based on these and other statistics shown in Table 2. Each of the seventy-five industries has been classified according to several criteria: its foreign investment proxy, its employment of scientists and engineers, its advertising intensity, and so forth. The first statistic in the first row of Table 2 indicates that between 1965 and 1971, the average industry exported 4.4 percent of its domestic shipments. The next four statistics show that industries in the first quartile of foreign investors (the first 18 in Table 1) exported 6.0 percent of domestic shipments on average, that those in the second quartile exported 5.9 percent on average, and so forth. Thus, by reading across the rows, we can see how export performance varies with the level of foreign investment.

The statistics in the first row take no account of the

Table 1

Statistics for Seventy-five U.S. Manufacturing Industries

IRS Number	Name	Foreign Investment Proxy	Export Share	Import Share	Change in Export Share	Change in Import Share	Technical Intensity	Advertising Intensity
2840	Soap	3.30	1.92	0.32	−0.11	0.01	4.45	16.96
2830	Drugs	2.93	6.80	2.20	0.31	0.38	8.09	11.71
2086	Soft Drinks	2.77	0.87	0.19	0.05	−0.02	1.31	8.46
3570	Office Machinery	2.70	15.12	4.87	7.77	2.96	9.36	0.79
3860	Photo Equipment	2.59	9.32	4.41	1.08	1.43	8.64	2.65
2910	Petroleum	2.22	2.51	5.90	−0.22	1.17	8.37	0.43
3420	Hardware	1.80	3.94	3.21	0.13	1.63	2.03	4.60
3830	Optical and Medical	1.63	8.07	5.03	0.74	0.89	4.42	4.59
2040	Grain Mill Products	1.53	5.56	0.43	−0.33	0.03	1.59	7.19
3010	Rubber	1.36	2.56	3.31	−0.14	2.64	3.37	2.23
3660	Radio and TV	1.24	3.90	6.18	0.86	4.84	10.93	2.40
2698	Paper	1.21	1.17	0.29	0.16	0.14	1.33	0.98
3710	Motor Vehicles	1.16	5.71	7.87	2.14	7.68	3.12	1.20
3298	Minerals	1.16	3.95	5.10	0.41	1.38	2.51	1.01
3530	Construction Equipment	1.04	20.97	1.68	1.98	0.89	5.03	0.80
3630	House Appliances	0.99	3.05	3.61	−0.34	2.51	2.92	3.15
3330	Nonferrous Metals	0.89	3.12	8.54	0.85	−0.74	3.33	0.43
2810	Chemicals	0.79	9.35	3.07	1.08	1.31	8.76	1.18
2850	Paints	0.75	1.77	0.04	0.30	0.00	5.80	2.31
3410	Metal Cans	0.74	0.41	0.14	−0.22	0.06	2.47	1.05
2020	Dairy Products	0.72	1.20	0.76	0.04	0.09	0.64	3.87
3430	Heating and Plumbing	0.68	3.14	0.39	0.28	0.22	2.47	1.41
2898	Other Chemicals	0.66	9.32	2.34	0.51	0.27	5.70	1.81
2712	Periodicals	0.64	2.51	0.26	−0.03	0.29	0.36	2.12
3550	Special Machinery	0.59	17.84	6.98	3.74	4.04	4.50	1.14
2098	Other Food	0.58	5.97	2.60	0.34	0.11	1.70	6.64
3698	Other Electrical Products	0.53	6.22	2.78	0.77	1.41	7.28	1.62
3210	Glass	0.51	4.04	3.67	−0.15	0.95	2.17	0.95
3560	General Machinery	0.49	10.03	3.80	1.69	2.04	4.50	1.19
2030	Canned Foods	0.48	2.92	2.92	−0.18	0.36	1.30	3.97
3810	Scientific Equipment	0.46	15.15	1.92	1.97	0.89	9.42	1.39
3598	Miscellaneous Machinery	0.45	7.95	1.71	−1.26	0.20	5.10	1.28
3310	Ferrous Metals	0.43	2.46	5.92	1.22	2.42	2.48	0.24
2050	Bakery Products	0.39	0.09	0.36	−0.38	0.15	0.57	4.95
3520	Farm Machinery	0.39	10.10	6.99	−2.12	0.55	3.56	1.06
3440	Structural Metal	0.38	2.48	0.39	−0.34	0.29	2.78	0.70
3580	Service Machinery	0.35	8.48	0.57	−0.40	0.52	4.50	1.62
3540	Metalworking	0.34	7.53	3.08	0.94	0.66	3.82	1.14
2620	Pulp and Paper	0.24	7.11	14.86	1.71	−0.86	2.43	0.84
3990	Misc. Manufacturing	0.24	4.90	9.93	0.86	3.43	1.08	3.22
3270	Concrete	0.22	0.14	0.11	0.00	0.01	2.07	0.54
3461	Metal Stamping	0.21	4.71	0.34	0.79	0.23	1.90	0.99

Table 1 – Continued

IRS Number	Name	Foreign Investment Proxy	Export Share	Import Share	Change in Export Share	Change in Import Share	Technical Intensity	Advertising Intensity
2711	Newspapers	0.19	0.05	0.08	−0.00	0.04	0.08	0.45
3870	Watches	0.19	1.55	17.44	0.22	2.09	2.38	6.89
2998	Other Petroleum	0.19	14.85	0.08	−0.05	0.07	3.89	1.33
3240	Cement	0.18	0.32	1.72	−0.08	1.13	2.07	0.16
2100	Tobacco	0.18	3.16	0.21	0.84	0.15	1.41	6.92
2715	Books	0.17	3.63	2.06	0.46	0.28	0.36	3.68
3662	Electronics	0.17	7.41	2.99	5.38	1.86	7.28	1.00
3798	Other Transportation Equipment	0.16	3.26	7.06	−1.04	3.96	1.95	0.68
2410	Logging	0.15	7.06	9.73	2.63	1.88	0.38	0.29
2310	Men's Clothing	0.14	0.80	3.29	0.28	2.25	0.21	1.92
3930	Ordnance	0.13	12.29	1.84	−4.64	0.38	14.72	1.67
3720	Planes	0.13	10.67	1.31	6.18	0.26	14.63	0.28
3498	Miscellaneous Fabricated Metals	0.12	4.65	3.65	0.39	1.33	2.47	1.00
2084	Liquors	0.12	0.88	27.31	−0.08	2.66	1.31	3.72
2228	Weaving	0.11	2.86	4.65	0.11	0.92	0.92	0.71
2798	Printing	0.10	0.66	0.27	−0.25	0.12	0.36	0.88
2060	Sugar	0.09	0.34	26.89	0.09	2.72	2.13	0.53
2430	Plywood	0.09	0.81	6.03	0.28	0.77	0.46	0.68
3450	Screws	0.09	2.18	3.19	0.59	1.64	2.05	0.72
2010	Meat	0.08	1.55	3.75	−0.07	0.94	0.58	2.18
3140	Footwear	0.08	0.28	9.24	−0.02	9.16	0.28	2.55
2398	Miscellaneous Textiles	0.07	2.35	1.08	−0.97	0.13	0.46	1.09
2298	Other Textiles	0.07	2.02	7.45	−0.17	−1.74	0.96	0.83
2250	Knitting Mills	0.06	0.74	4.15	−0.04	2.60	0.33	1.68
2082	Beer	0.06	0.18	0.97	−0.07	−0.02	1.31	9.68
2330	Women's Clothing	0.05	0.51	3.45	0.03	2.25	0.21	1.97
2590	Other Furniture	0.04	0.81	1.83	0.05	1.24	0.65	1.49
3098	Plastic Products	0.04	2.25	2.21	1.14	0.93	2.35	1.22
2510	House Furniture	0.04	0.43	1.83	−0.11	1.24	0.65	2.34
2498	Other Wood	0.02	1.41	4.99	0.09	0.82	0.67	0.95
3198	Other Leather	0.01	2.65	10.06	0.12	3.72	0.69	2.25
2380	Other Apparel	0.01	0.83	7.96	−0.06	3.43	0.21	1.73
3730	Ships and Boats	0.01	2.30	0.90	1.26	0.71	4.31	0.85

Sources of data are described in the Statistical Appendix to chapter 3 of C. Fred Bergston, Thomas Horst, and Theodore Moran, *American Multinationals and American Interests*, Brookings Institution, forthcoming.

The foreign investment proxy is an industry's foreign dividends and tax credits as a percentage of its firms' total assets, the percentage being averaged over the years 1965–71.

The export share is the industry's exports as a percentage of domestic shipments averaged over the years 1965–71.

The import share is U.S. imports as a percentage of comparable domestic shipments averaged over the years 1965–71.

The growth of exports is measured by the difference between the ratio of exports to domestic shipments averaged over the years 1969–71, and the comparable ratio averaged over the years 1965–67.

The growth of imports is the difference between the ratio of U.S. imports to comparable domestic shipments averaged over the years 1969–71 and the comparable ratio averaged over the years 1965–67.

Technical intensity is measured by the employment of scientists and engineers as a percentage of total industry employment in 1970.

Advertising intensity is measured by advertising expenditures as a percentage of total industry assets averaged over the seven years 1965–71.

technological intensity or other characteristics of the industries. Accordingly, the second and third rows contrast the export performance of high- and low-technology industries. Across the board, the high-technology industries exported 8.1 percent of domestic shipments, and low-technology industries averaged only 2.3 percent; those high-technology industries that were also in the first quartile of foreign investors exported 7.6 percent compared to 9.7 percent for those in the second quartile, and so forth. Thus, by reading up and down the columns, we can see roughly how export performance varies with the characteristics of the industries, holding the foreign investment level more or less constant.

Several features of Table 2 are striking. U.S. export performance was clearly stronger in the high-technology and especially in the machinery industries; the former averaged exports equal to 8.1 percent of

Table 2

Cross-Tabulation of Industries' Average Export Performance, 1965–71, According to Foreign Investment Level and Other Industry Characteristics

		Foreign Investment			
	All	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
All	4.4	6.0	5.9	4.3	1.3
High technology	8.1	7.6	9.7	7.8	2.3
Low technology	2.3	3.5	2.5	3.0	1.3
High advertising	3.1	4.6	2.4	2.8	1.0
Low advertising	5.0	7.7	7.5	4.8	1.4
Machinery	10.6	18.0	11.0	8.4	2.3
Nonmachinery	3.0	4.5	3.6	4.1	1.2
High education	6.5	6.6	7.9	6.2	1.0
Low education	2.2	3.1	2.5	2.9	1.4
High earnings	5.7	6.9	6.4	5.0	1.3
Low earnings	2.4	4.3	3.0	3.0	1.3
High experience	4.5	4.1	5.2	5.1	1.4
Low experience	4.2	8.9	6.7	3.3	1.3
High skill group 1	7.5	8.7	8.8	6.1	1.5
Low skill group 1	2.6	3.3	3.3	3.2	1.3
High skill group 2	4.6	5.8	7.5	2.3	1.0
Low skill group 2	4.2	6.1	4.1	5.7	1.5
High skill group 3	6.9	7.4	8.9	5.2	1.4
Low skill group 3	2.6	4.3	2.5	3.6	1.3
High skill group 4	3.1	5.6	3.5	1.7	0.7
Low skill group 4	5.0	6.2	7.0	6.1	1.5
High skill group 5	4.9	7.6	6.0	4.0	1.3
Low skill group 5	3.9	5.2	5.8	4.7	1.3
High skill group 6	3.0	3.4	4.3	4.3	1.4
Low skill group 6	5.7	7.7	7.1	4.2	1.1
High skill group 7	2.9	3.4	4.3	2.8	0.9
Low skill group 7	5.0	6.7	6.6	5.1	1.5
White	6.0	6.9	6.7	5.7	1.3
Nonwhite	2.1	3.7	2.9	2.3	1.3
Male	4.9	6.8	5.8	5.0	1.1
Female	3.4	4.3	6.1	3.1	1.5
Unionized	4.4	3.8	4.4	5.5	1.9
Non-unionized	4.3	7.8	7.0	3.2	1.3

domestic shipments and the latter 10.6 percent. These industries employ proportionately higher numbers of well-educated, highly skilled, and highly experienced workers.

Although these characteristics of U.S. industries with strong export records have been noted by numerous authors, Table 2 also reveals the separate contribution of foreign investing to exporting. As we read across the rows of Table 2, we can see the marked difference between industries in the top three quartiles of foreign investors and those in the bottom quartile. Industries with little or no foreign investment export only 1.3 percent of domestic shipments, and that poor performance cannot be attributed to low technology, low education or skill among the labor force, or any other industry attribute we have measured. It appears that a modest amount of foreign investment, perhaps in the form of overseas sales and service affiliates, may be a prerequisite to exporting. But once we move into the top three quartiles of industries, further increases in foreign investment are not matched by comparable increases in U.S. exports.

The relationship between foreign investment and U.S. *imports*, which is analyzed in Table 3, is somewhat the opposite of that with U.S. exports. Imports are higher in industries marked by *low* foreign investment, low technology, low education, low annual earnings, a low percentage of professional, technical and kindred workers, a high percentage of operatives, and a high percentage of nonwhite workers. This pattern proba-

Table 3

Cross-Tabulation of Industries' Average Import Performance, 1965–71, According to Foreign Investment Level and Other Industry Characteristics

		Foreign Investment			
	All	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
All	4.3	3.7	2.3	5.6	5.3
High technology	3.2	4.1	3.0	1.9	0.9
Low technology	4.8	3.0	1.7	7.0	5.6
High advertising	4.6	2.9	1.2	11.4	5.2
Low advertising	4.1	4.7	2.9	3.6	5.4
Machinery	3.0	3.3	3.0	3.3	0.9
Nonmachinery	4.5	3.7	2.1	6.3	5.6
High education	3.8	3.8	2.7	6.7	0.7
Low education	4.7	2.9	1.8	4.9	6.2
High earnings	3.5	4.0	2.4	5.0	1.3
Low earnings	5.4	2.9	2.0	6.8	6.4
High experience	3.9	4.2	2.5	2.7	11.3
Low experience	4.5	2.9	2.1	8.9	4.2
High skill group 1	2.5	3.7	2.3	1.6	0.6
Low skill group 1	5.3	3.6	2.4	8.0	5.9
High skill group 2	3.9	2.7	2.0	5.6	7.1
Low skill group 2	4.5	4.3	2.8	5.7	4.7
High skill group 3	3.4	3.4	2.7	4.5	1.7
Low skill group 3	4.9	4.0	1.9	6.5	5.7
High skill group 4	3.7	1.9	1.1	5.2	8.0
Low skill group 4	4.5	4.8	2.9	6.0	4.6
High skill group 5	3.6	5.0	2.5	4.7	1.6
Low skill group 5	4.8	3.0	2.1	6.9	6.6
High skill group 6	4.7	4.6	2.5	6.6	4.9
Low skill group 6	3.8	3.1	2.2	4.9	6.4
High skill group 7	5.9	3.6	3.0	7.7	8.5
Low skill group 7	3.6	3.7	2.0	4.4	4.2
White	3.5	3.8	2.2	5.0	3.7
Nonwhite	5.2	3.4	3.0	6.6	5.7
Male	4.4	4.1	2.3	5.9	5.6
Female	4.1	2.9	2.4	5.1	5.1
Unionized	4.3	5.1	2.9	4.7	3.5
Non-unionized	4.2	2.5	2.0	6.5	5.5

bly reflects more the cheap-labor or natural-resource characteristics of certain industries (e.g., pulp and paper, watches and clocks, liquors, sugar, furniture, and leather goods) than the absence of foreign investment per se, the evidence will not support any conclusion that foreign investment has led to higher than average imports.

Looking only at the *levels* of U.S. exports and imports and their relationship to foreign investment, one might wonder why the AFL-CIO has been so upset. The reasons become more apparent when we turn to Tables 4 and 5, which show how U.S. exports and imports as a percentage of domestic shipments increased between 1965–67 and 1969–71. According to our way of measuring export or import growth, if one or the other increased from, say, 5 percent to 6 percent of domestic shipments, we would show an increase of one percentage point. According to Table 4, the average industry increased its exports by only one half of a percentage point between 1965–67 and 1969–71. As for variations around this low average, we see that the traditionally strong export industries — the high-technology industries and the machinery manufacturers — showed the largest increases. The low-technology industries barely maintained their low export ratios over this seven-year interval. Finally, we might note that here, as before, industries in the lowest quartile of foreign investors had slower-growing exports than did those in the top three

Table 4

Cross-Tabulation of Industries' Export Growth, 1965–67 to 1969–71, According to Foreign Investment Level and Other Industry Characteristics

		Foreign Investment			
	All	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
All	0.50	0.82	0.32	0.78	0.11
High technology	1.03	1.14	0.58	1.56	1.27
Low technology	0.22	0.32	0.09	0.50	0.04
High advertising	0.19	0.23	0.07	0.46	−0.03
Low advertising	0.67	1.56	0.44	0.89	0.16
Machinery	1.46	4.88	1.09	0.36	1.27
Nonmachinery	0.30	0.31	−0.03	0.89	0.04
High education	0.79	0.94	0.42	1.25	0.31
Low education	0.21	0.24	0.15	0.44	0.07
High earnings	0.74	1.16	0.38	0.92	0.38
Low earnings	0.17	0.13	0.04	0.54	0.03
High experience	0.50	0.33	0.23	1.05	0.20
Low experience	0.50	1.60	0.43	0.48	0.09
High skill group 1	1.12	1.50	0.81	1.18	0.51
Low skill group 1	0.16	0.14	−0.12	0.55	0.06
High skill group 2	0.64	1.17	0.78	0.26	0.20
Low skill group 2	0.41	0.60	−0.19	1.16	0.07
High skill group 3	0.89	1.27	0.52	1.05	0.17
Low skill group 3	0.25	0.25	0.11	0.58	0.10
High skill group 4	0.45	1.23	0.19	0.24	−0.08
Low skill group 4	0.53	0.56	0.38	1.17	0.15
High skill group 5	0.54	0.71	0.23	0.87	0.31
Low skill group 5	0.47	0.87	0.45	0.65	0.03
High skill group 6	0.30	0.22	−0.16	1.31	0.03
Low skill group 6	0.70	1.20	0.67	0.39	0.33
High skill group 7	0.29	0.12	−0.02	0.36	0.14
Low skill group 7	0.59	1.11	0.33	0.82	0.12
White	0.68	0.97	0.32	0.95	0.36
Nonwhite	0.26	0.43	0.34	0.55	0.04
Male	0.54	1.05	0.26	0.56	0.24
Female	0.44	0.35	0.45	1.15	−0.01
Unionized	0.44	0.19	−0.03	1.11	0.26
Non-unionized	0.54	1.32	0.58	0.48	0.09

quartiles. But, generally speaking, the relationship between foreign investment levels and export growth was random.

Table 5 examines the growth in U.S. imports between 1965–67 and 1969–75. Imports were growing much faster than exports: the average increase for imports was 1.30 percentage points, or two and a half times the comparable increase in exports. As Table 5 makes abundantly clear, this growth in U.S. imports was not focused in a few isolated industries. Virtually every type of industry witnessed an increase in the import share of one to two percentage points. Perhaps the most interesting pattern of variation around this high average is that for the eighteen industries in the *top* quartile of foreign investors (see the second column of Table 5). Within this group of investors, imports were growing especially quickly in industries whose workers had more education, higher earnings, and more experience and were operatives, not laborers, nonwhite and covered by a union contract.

Of course, our statistics do not indicate whether foreign investment was the *cause* of this rapid growth of imports. Looking back to Table 1, we can see that the industries in question were motor vehicles, radio, television and communications equipment, office machinery, and rubber products. Although one would have to undertake detailed industry studies to determine the role of foreign investment in promoting imports in these

Table 5

Cross-Tabulation of Industries' Import Growth, 1965–67 to 1969–71, According to Foreign Investment Level and Other Industry Characteristics

		Foreign Investment			
	All	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
All	1.30	1.62	0.79	1.15	1.67
High technology	1.14	1.44	1.11	0.65	0.71
Low technology	1.39	1.91	0.50	1.33	1.72
High advertising	1.50	1.44	0.17	1.73	3.01
Low advertising	1.20	1.85	1.07	0.95	1.18
Machinery	1.46	1.93	1.52	1.32	0.71
Nonmachinery	1.27	1.58	0.45	1.11	1.72
High education	1.14	1.74	0.94	0.66	0.27
Low education	1.47	1.05	0.52	1.51	1.93
High earnings	1.08	1.88	0.89	0.67	0.61
Low earnings	1.62	1.10	0.22	1.98	1.95
High experience	1.10	1.85	0.71	0.46	1.77
Low experience	1.47	1.26	0.88	1.92	1.65
High skill group 1	1.04	1.55	1.08	0.51	0.42
Low skill group 1	1.45	1.70	0.53	1.53	1.81
High skill group 2	0.90	0.78	0.86	1.04	0.92
Low skill group 2	1.57	2.16	0.71	1.24	1.93
High skill group 3	1.16	1.44	1.03	1.06	0.88
Low skill group 3	1.40	1.85	0.52	1.22	1.76
High skill group 4	0.68	0.63	0.16	0.98	0.94
Low skill group 4	1.62	2.25	1.08	1.28	1.86
High skill group 5	1.12	1.99	0.98	0.83	0.99
Low skill group 5	1.45	1.44	0.52	1.59	1.90
High skill group 6	1.51	2.18	0.47	1.31	1.89
Low skill group 6	1.10	1.27	1.01	1.04	1.04
High skill group 7	0.69	0.16	0.71	0.72	1.05
Low skill group 7	1.56	2.04	0.82	1.40	1.89
White	1.20	1.34	0.79	0.93	2.96
Nonwhite	1.44	2.35	0.77	1.45	1.32
Male	1.17	1.77	0.84	0.98	1.12
Female	1.51	1.32	0.67	1.45	2.15
Unionized	1.25	2.44	0.76	0.60	1.29
Non-unionized	1.33	0.97	0.81	1.65	1.71

Notes to Tables 2 through 5

Sources of statistics are given in the statistical appendix to Chapter 3 of C. Fred Bergsten, Thomas Horst, and Theodore H. Moran, *op. cit.*

The cross-tabulations are based on industries classified according to the following criteria:

- The first quartile of foreign investors are those ranked from one to eighteen in Table 1; the second quartile are those ranked from nineteen to thirty-seven, and so forth.
- "High technology" were those with scientists and engineers (a subclass of skill group 1) in excess of 3.2 percent of total employment in 1970.
- "High advertising" were those industries with advertising expenditures equal to 2 percent or more of total assets averaged over the years 1965–71.
- "Machinery" industries were those judged by the author to be manufacturing durable capital equipment for sale to other producers.
- "High education" were those industries in which the median years of education of employees was greater than twelve in 1970.
- "High experience" were those industries in which more than 55 percent of the employees were between 30 and 54 years old in 1970.
- "High earnings" were those industries whose employees' median yearly earnings exceeded $7,000 in 1970.
- "High skill group 1" were those industries in which more than 8.8 percent of all employees were professional, technical, and kindred workers in 1970.
- "High skill group 2" were those in which more than 5.8 percent of all employees were managers and kindred workers in 1970.
- "High skill group 3" were those in which more than 12.5 percent of employees were clerical and kindred workers in 1970.
- "High skill group 4" were those in which more than 3.0 percent of employees were sales workers in 1970.
- "High skill group 5" were those in which more than 19.2 percent of employees were craftsmen, foremen, and kindred workers in 1970.
- "High skill group 6" were those in which more than 43.2 percent of employees were operatives in 1970.
- "High skill group 7" were those in which more than 5.0 percent of employees were laborers in 1970.
- "Nonwhite" industries were those in which more than 9.5 percent of employees were nonwhite in 1970.
- "Female" industries were those in which more than 28.1 percent of all employees were female in 1970.
- "Unionized" industries were those in which more than 70 percent of all employees work in plants in which at least half of all production workers were covered by union contracts.

industries, casual evidence suggests that the relationship between foreign investment and importing varies from industry to industry. A substantial portion of the increased imports of motor vehicles did come from the Canadian subsidiaries of the Big Three U.S. automobile producers and were induced by the tariff reductions of the Canadian-American Automotive Pact of 1965. This would seem to be a classic case of the substitution of foreign for domestic investment and employment induced by a tariff reduction. One should not ignore, of course, the growing automotive exports of Japanese and German companies to the United States. In radio, television, and communications equipment, the growth of imports was probably due to the growing competitiveness of Japanese producers (such as Sony and Panasonic) and the induced export of production and jobs by U.S. companies to the Far East. In this instance, U.S. investments abroad appear to be more "defensive" than they were in the case of automotive imports. Finally, the growth of U.S. imports of rubber products probably consisted largely of radial tires from European producers, and the correlation with U.S. investments abroad may well be spurious. We must be wary of drawing any simplistic conclusions from these sorts of statistics.

Summary and Conclusion

Our analysis has focused on the microeconomic relationship between U.S. investments abroad and U.S. exports, imports, and employment. Although foreign investment may have important effects on the general equilibrium of the world economy, the public policy debate in the United States has focused largely on microeconomic issues. The labor unions have charged that U.S. multinational firms displace U.S. exports, augment U.S. imports, and in either instance export U.S. jobs. The multinationals have emphasized the positive effects of foreign investment on U.S. exports and employment and claimed that when foreign investment substitutes for domestic, the substitution is induced by higher foreign tariffs, the growing competitiveness of foreign producers, and other economic factors that leave them little choice but to invest overseas.

Microeconomic theory indicates that these views are not necessarily contradictory. Even if one regards foreign demand for U.S. products as fixed, a variety of economic factors — tariffs, wage rate differentials, the size of the foreign market, and the firm's own subjective assessment of the costs and benefits of investing overseas — influence the choice between domestic and foreign production. In some cases exporting may be a viable alternative (though, presumably, a less profitable one in the long run) to overseas production, and in other instances it is not.

But one should not base policy analysis on the assumption that foreign demand for U.S. products is fixed. A multinational's foreign activities include a wide range of activities — gathering market information, sales, servicing and distribution, adapting products to local market specifications — aimed at expanding the size of the foreign market rather than merely relocating production. This point is critical in two respects: understanding why there is no clear statistical tendency for U.S. exports to fall or imports to rise as foreign investment expands, and why broad restrictions on foreign investment — such as the balance-of-payments guidelines or proposed changes in U.S. taxation of foreign investment income — might have an ambiguous effect on U.S. production and employment.

To predict the impact of a change in U.S. policy requires a fully specified model of foreign trade and investment behavior. Although many of the factors affecting the location of production can be quantified, those influencing the size of the foreign market cannot. Our statistical analysis focused on the de facto relationship between U.S. investments abroad and U.S. exports and imports. While one cannot infer from this analysis what would have happened if U.S. policy were different from what it was, one might be able to identify the relative importance of substitutional and complementary factors encouraging American firms to invest overseas. A consistent tendency of exports to fall or imports to rise as foreign investment expands might be evidence of the historical importance of substitutional effects, and the opposite statistical relationship would underscore the importance of complementary forces. If both effects are weak or of roughly equal historical significance, the statistical relationship will be haphazard.

We have examined differences among seventy-five manufacturing industries' average export and import levels from 1965 to 1971 and the growth in these levels over the same period. On the whole we have failed to uncover any consistently strong statistical relationship, positive or negative, between U.S. investments abroad and any of our measures of trade performance. Although our data and our methodology have obvious flaws, one cannot escape the impression that the microeconomic relationship between international trade and investment is complex and/or weak. We do have some tentative evidence that a modest amount of overseas investment, perhaps in the form of sales and service facilities, is a prerequisite to U.S. exporting. We also uncovered some evidence that certain industries marked by high foreign investment — motor vehicles, radio, television and communications equipment, office machinery, and rubber products — did experience faster than average import growth between 1965 and 1971. Without more detailed industry studies, however, it is impossible to determine the extent to which foreign investment was the cause, the effect, or merely a spurious correlate of the growth of imports. If U.S. foreign investment policy is to be geared more towards protecting U.S. employment than it was in the past, then it would also have to be more selective and discriminating than it has traditionally been. Broad and undiscriminating changes in U.S. policy could do more harm than good.

Literature Cited

1. Frank, Robert H., and Richard T. Freeman. "The Distributional Consequences of Direct Foreign Investment." Presented at the Conference on the Impact of International Trade and Investment on Employment. Washington, D.C., December 2 and 3, 1976.

The Distributional Consequences Of Direct Foreign Investment

Robert H. Frank and Richard T. Freeman*

Introduction and Summary

When countries can make adjustments through offsetting stabilization policies, the most important long-run effect of direct foreign investment (DFI) will be a redistribution of income.[1] This report examines the effect of overseas investment by U.S. firms on both the short-run level of employment demand and the long-run distribution of incomes within the United States.

Section 1 begins with a summary of the findings of our earlier study [6] of the short-run employment demand effects of foreign investment. This section considers the question of what fraction of the overseas markets that are presently served by foreign subsidiaries could have been served by exporting from the United States. We conclude that, even though sales in these foreign markets would shrink by more than half in the event of a ban on foreign investment, such a ban would nevertheless be likely to produce an increase in domestic employment demand. Estimates of the short-run employment demand reductions that result from DFI are presented for the economy's manufacturing industries.

Section 2 presents an extension of these findings, in which we have broken down the employment demand effects of DFI by occupation. The question of what effect foreign investments have on the problem of bottlenecks in the demand for labor is then considered. We conclude that DFI exacerbates such bottlenecks slightly by causing much larger reductions in blue collar than in white collar employment demands.

Section 3 examines the question of how long labor markets take to adjust to the employment demand reductions associated with the overseas activities of multinational subsidiaries. A dynamic simulation model is used in the study of this question and we conclude that almost the entire membership of a cohort of workers who lose their jobs as a result of these employment demand reductions can expect to have been placed in new jobs within a matter of months.

Taking recognition of the fact that short-run dislocations are only a small part of the overall effect of DFI, section 4 undertakes an analysis of the long-run effect of capital outflows on both the size and composition of national income in the United States. We conclude that when account is taken of the leakage of tax revenues into the treasuries of host countries, foreign investment results in a slightly lower level of equilibrium U.S. national income. As far the distribution of income is concerned, the principal long-run consequence of DFI appears to be a moderate shift favoring capital.

1. Home-Foreign Substitution and the Short-Run Domestic Employment Demand Effects of Foreign Investment

Estimates of the effect of DFI on short-run domestic employment demands are usually constructed by aggregating various positive and negative effects attributed to the overseas activities of subsidiaries. The principal negative effect is usually calculated as the fraction of foreign subsidiary employment that could have been retained in the United States had MNCs attempted to serve foreign markets by exporting from domestic production sites. The main offset to this export displacement is an export stimulus effect, which represents the domestic employment required to meet foreign subsidiaries' demands for U.S. exports of intermediate products.[2]

Subsidiary imports from U.S. parents and other U.S. firms account for only a small fraction of subsidiary net sales (4 percent for all industries in 1970), and the procedures used for calculating the magnitude of the export stimulus effect have accordingly generated little disagreement among researchers. Most of the controversy over whether the net domestic employment effect of DFI is positive or negative has focused instead on the calculation of the export displacement effect. The central issue in this discussion has been the question of what MNCs would or could have done had they not undertaken foreign investment projects.

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[1] A recent study that makes this point is [13].

[2] Other employment stimulating effects that have been mentioned include increased employment in domestic MNC headquarters, increased employment associated with export of complementary MNC products, and additional domestic employment stimulated indirectly by increased incomes and export demand abroad — all of which are likely to be minor in relation to the direct, production related effects on which we focus. For more detail on these and related issues, see [18, 8, 9].

Studies that have produced conclusions of domestic job stimulus have usually found that, largely because of cost advantages in overseas sites, markets now being served by foreign subsidiaries of MNCs could not have been served by export from the United States. These markets would thus have been lost entirely to foreign competitors had MNCs been prevented from producing overseas. Studies that identify a major negative net employment effect of DFI have found that a large fraction of overseas markets could have been served by U.S. exports.

Debate has continued on this issue largely because there has been virtually no hard evidence on the critical question of what the alternatives to subsidiary operations really are for U.S. MNCs. The most respected evidence concerning alternatives to overseas production currently exists in the form of statistical studies that associate various forms of domestic and foreign activity measures. In out recent study [6], we argue that evidence from this source has been misinterpreted and provides no real indication of what MNCs would have done in the absence of a foreign investment alternative.

As a simple illustration, consider the case of an overseas subsidiary that requires $50 of intermediate inputs from its U.S. parent for each $100 in foreign sales. In the context of a growing foreign market, one would observe a positive association between a subsidiary's sales and U.S. exports to the subsidiary. This positive association clearly does not imply, however, that U.S. exports to the subsidiary host country would decline if its operations were prohibited. If U.S. production costs are not much higher than foreign costs and if foreign demand is not highly elastic, U.S. exports could increase substantially in the event of such a restriction.

The principal contribution of our study [6] is the development of a specific analysis that is capable of generating evidence on the critical counterfactual question, What would have happened if DFI had been prohibited. This analysis involves the comparison of the MNC operating under widely different policy regimes. The first places no restrictions on the MNC's overseas activities, whereas the second denies the MNC the option of operating foreign subsidiaries. The first regime corresponds approximately to the present environment in which MNCs operate, whereas the second is an essentially hypothetical construct. MNCs operating under the first policy regime will, in general, elect to serve foreign markets from foreign production sites. Under the second regime MNCs are assumed to serve foreign markets by exports.

The ratio of MNC employment in the second regime to employment in the first defines our measure of the extent to which MNC overseas subsidiary employment substitutes for or displaces domestic employment. At one extreme, if MNC employment is the same under both cases, the substitution ratio takes the value unity, indicating that employment in overseas subsidiaries displaces domestic employment on a one-for-one basis. Alternatively, if export from the United States is not economically viable, the substitution ratio is zero, indicating no job displacement. Between these two extremes there is a full range of intermediate cases.

The principal factors that affect the substitution ratio are inferred from an economic model of firm behavior. One key factor is the degree of monopoly power exercised by the MNC in foreign markets. When the MNC sells a highly standardized product in nearly perfect competition with many foreign producers of nearly identical products, market power is low. In this competitive situation the higher price forced by the higher costs of producing in the United States will cause the MNC to lose most or all of its foreign market if it is constrained to produce at home. Most MNCs are in fact far from perfect competitors. Instead, they tend to be large, technology-intensive organizations which sell highly differentiated products, and which, in consequence, possess substantial market power.

In many instances this may enable the MNC to absorb higher U.S. production costs without losing all its foreign sales. In [6] we describe a procedure whereby the degree of MNC market power (specifically the elasticity of the demand curve facing the firm) can be estimated with information taken from the income statements of U.S. multinationals surveyed by the Department of Commerce.

Another major factor affecting home-foreign substitution is the extent to which the cost of supplying foreign markets by U.S. exports exceeds the costs of foreign production. Such cost differences are due largely to differences in unit labor costs, transport and handling costs, tariffs, and other similar trade restrictions. Using a variety of data sources, we have constructed estimates of home to foreign production cost ratios for major manufacturing industry groups. These cost ratio estimates are then combined with demand sensitivity estimates in a procedure that yields estimates of the substitution ratios described above.

Once estimates of these home-foreign substitution parameters were obtained,[3] we were able to calculate the net employment gain or loss associated with a given year's foreign investment. Here we attempted to improve on existing work by explicitly taking into account not only DFI-related employment effects in the manufacturing sectors of first impact, but also employment effects related to changes in the demand for intermediate products required in industries that invest overseas. Their exclusion would result in an underestimation of the direct effect on U.S. employment. In primary metals, for example, shifting $1 million worth of activity overseas has a relatively small direct impact on domestic employment in that industry because of labor's relatively small share in industry value added. Yet the total impact on U.S. employment is really much larger because a reduction of domestic activity in the metals industry means that sectors providing intermediate inputs (many of which are highly labor-intensive) will experience corresponding declines. There are analogous secondary effects augmenting domestic employment, which need to be taken into account in estimating the export stimulus effects of DFI.

To trace out both primary and secondary effects we used an aggregated version of the Bureau of Labor Statistics 1963 input-output table for the U.S. economy, updated to 1970, together with corresponding capital-output and employment-output ratios. The employment gain or loss associated with a given year's real foreign investment as measured by Department of Commerce estimates of property, plant, and equipment expenditures of U.S. wholly owned subsidiaries was found by first computing the full (i.e., the primary and secondary) "export displacement" effect associated with these activities, modified by the appropriate substitution factor for each industrial sector. This job loss figure was then offset by a similar calculation of the export stimulus effect from the addition of U.S. export requirements of U.S. foreign subsidiaries.[4]

Our estimates of the substitution parameters and net employment demand reductions attributable to the 1970 flow of DFI are reported for several large manufacturing industries in Table 1. Column 1 of Table 1 reports our best estimates of the industry substitution parameters $\sigma_i{}^*$. Column 2 lists DFI flows (property, plant, and equipment expenditures) by industry for the year 1970. Column 3 reports the net employment demand effects by industry based on the substitution parameter entries of column 1.

Because many of the essential inputs to the calculations were inferred from somewhat incomplete data, and the estimation procedure itself is founded on a number of strong assumptions, we emphasize that the figures in column 3 of Table 1 are, at best, only indicative of the scale and distribution of DFI-related job loss. In particular, the results above are quite sensitive to the values of the home-foreign substitution factors; fur-

Table 1

Substitution Ratios and Net Employment Demand Effects for 1970 DFI Vector

Industry Name	1 Substitution parameter σ^*	2 DFI ($1000)	3 Net Employment Demand Change* ($\sigma = \sigma^*$)	4 ($\sigma = \sigma^*/2$)	5 ($\sigma = 2\sigma^*$)
Food	0.368	266,879	−6,835	−2,644	−15,173
Chemicals	0.441	882,445	−14,944	−5,833	−33,056
Primary and fabricated metals	0.245	336,535	−8,854	5,063	−36,711
Electrical machinery	0.345	359,044	−17,620	−5,017	−42,806
Nonelectrical machinery	0.358	1,242,846	−46,905	−16,636	−98,283
Transportation equipment	0.191	782,366	−7,210	310	−22,271
Rubber	0.463	123,594	−5,062	−1,197	−12,790
Paper	0.463	320,929	−7,321	−2,549	−16,564
Other manufacturing	0.402	365,534	−4,439	2,865	−19,041
Nonmanufacturing (indirect only)	—	5,311,557	−44,278	6,072	−134,937
TOTAL	—	9,991,729	−160,377	−19,574	−441,706

*Change in number of jobs; minus indicates job loss.

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[3] The specific expression employed for estimating the substitution parameter is $\sigma\ (MC_F/MC_H)^{\eta}$, where MC_F is marginal production costs in the foreign market, MC_H is the cost of landing an additional unit of domestically produced output in the foreign market, and η is the price elasticity of demand in the foreign market.

[4] Estimates of the U.S. export share in total subsidiary intermediate input requirements were based on the 1970 Department of Commerce special survey of U.S. multinationals.

thermore, the estimation of these factors was based on data that stands out as the least reliable in the study. For these reasons we have calculated two additional sets of net employment effects, one based on substitution parameters set at half the values of our best estimates, another based on substitution parameters set at twice those values. These alternative employment demand estimates are reported in columns 4 and 5 of Table 1. Even for the estimates based on the low values of the substitution parameters (column 4), the export displacement effect was seen to dominate the export stimulus effect, resulting in a net employment demand reduction for each industry.

We have also computed break-even values for the substitution factors; i.e., values at which the export displacement effect is exactly offset by job gains associated with new exports, and at which the net job loss is zero. We found the average break-even value to be approximately equal to 0.10. This means that for there to be no net loss of production jobs, for every 100 jobs created overseas by U.S. subsidiaries, on average no more than ten U.S. jobs must be displaced in the same industry. Since all of the substitution factors that we calculated were well above this figure (the average value was, in fact, approximately 0.35), there is clearly a strong presumption that, even allowing for considerable deficiencies in the data, the net impact of foreign investment by U.S. multinationals is a substantial domestic employment demand reduction.

2. The Effect of DFI on the Occupational Composition of Domestic Employment Demand

In order to determine whether foreign investment improves or worsens the problem of bottlenecks in the labor market, it is necessary first to establish a criterion by which to measure imbalances in the composition of demand for labor. The theoretical concept that underlies this criterion is the model of unemployment dispersion and wage inflation introduced by Lipsey [10]. Lipsey's model considers a group of identical labor submarkets and concludes that wage inflationary pressures are minimized for a given aggregate unemployment rate when the unemployment rates in all the submarkets are equal. Lipsey's model has been generalized for the case of submarkets that have different wage levels (see [5]), a more realistic description of submarkets defined by skill category. Here the conclusion is that the least inflationary distribution of demands calls for relatively high unemployment rates at least temporarily in those submarkets with relatively high wage rates and vice-versa.[5] In terms of skill categories, a balanced composition of demand is one in which more skilled, high wage, groups have high unemployment rates and less skilled, low wage, groups have low unemployment rates.[6] Since the present distribution of unemployment across skill categories is precisely the reverse of the optimal distribution — more skilled groups now have the lowest unemployment rates — the generalized dispersion model reinforces a basic conclusion of the Lipsey model: any shift in the composition of demand in the direction of greater equality across skill categories constitutes a clear improvement over the composition of demand presently observed in the United States.

Employing this criterion, we have attempted to answer the question of whether DFI improves or worsens the problem of structural imbalances in the occupational distribution of employment demand. To do this

Table 2

Employment Demand Reductions from 1970 DFI Vector, by Occupational Category (four-order)

Occupational Category	1 Employment Demand Reduction (1000s)	2 Employment (1000s)	3 Demand Reduction Ratio (1÷2)×100	4 1970 Unemployment Rate (percent)
White collar	62.2	37,997	0.164	2.8
Blue collar	85.4	27,791	0.307	6.2
Service	8.6	9,712	0.088	5.3
Farm workers	4.2	3,124	0.134	2.6

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[5] With two submarkets the inflation minimizing distribution of employment rates must satisfy

$$\frac{e_1}{e_2} = \frac{w_2 g_2'(e_2)}{w_1 g_1'(e_1)} ,$$

where w_i is the wage rate, e_i the employment rate, and $g_i'(e_i)$ the slope of the Phillips curve for the *i*th market. See [5, p. 244].

[6] The submarkets with the higher wage rate must have a higher unemployment rate if wage inflation is to be minimized because of the larger than proportional contribution of the high wage submarket to the overall wage index. A given increase in unemployment is worth just as much in the low wage submarket as it would be in the high wage submarket, but produces a smaller boost in the aggregate rate of wage inflation when taken in the low wage submarket.

we have employed data from the 1970 National Industry Occupational Employment Matrix [16] in conjunction with our estimates of industry substitution ratios in carrying out an input-output calculation of the type described in the previous section.[7] The results of this calculation for the 1970 flow of DFI are reproduced in Table 2 for a four-order breakdown of occupational categories.

Column 1 of Table 2 lists the estimated employment demand reductions by occupational category. Column 2 lists total 1970 employment in these categories. In column 3 we have shown employment demand reduction ratios by occupational category, calculated as 100 times the ratio of occupational employment demand reduction to total occupational employment. Column 4 shows the 1970 occupational unemployment rates.

Most of the employment demand reductions are concentrated on white and blue collar workers, with service and farm workers experiencing only comparatively minor effects. Among the former groups, blue collar workers are far and away the hardest hit. In terms of our criterion for a balanced composition of demand, the entries of Table 2 suggest strongly that the foreign investment flows of 1970 have exacerbated the problem of structural bottlenecks in the labor market.[8]

"Blue collar" and "white collar" are extremely aggregative occupational categories and our conclusions might be modified if employment demand reductions were concentrated on high wage groups within each category. In order to investigate this possibility, we have repeated the original calculations in the context of a nine-order occupational breakdown. These results appear in Table 3.[9] Within the blue collar category, "operatives" experience substantially larger employment demand reductions than do workers in the more skilled "craftsmen, foremen and kindred" category. Within the white collar category, employment demand reductions are not highly concentrated within any of the four subgroups shown in Table 3. Accordingly, we conclude that the entries in Table 3 are generally consistent with the hypothesis that foreign investment outflows tend to create additional imbalances in the composition of demand for labor.

At this point we should stress that, for a number of reasons, the estimates reported in Tables 2 and 3 should be regarded as tentative. Because we lacked specific information on the types of activities that are transferred abroad, we constructed Tables 2 and 3 under the assumption that the labor requirements associated with each unit of export stimulus and export displacement are the same as the overall labor requirements vector for the particular industry in which they occur. Some other researchers who have addressed the issue of the effect of DFI on the composition of demand for labor

Table 3

Employment Demand Reductions from 1970 DFI Vector, by Occupational Category (nine-order)

Occupational Category	1 Employment Demand Reduction (1000s)	2 Employment (1000s)	3 Demand Reduction Ration (1÷2) × 100	4 1970 Unemployment Rate (%)
WHITE COLLAR				
Professional, technical, and kindred	21.7	11,140	.195	2.0
Managers, officials, and proprietors	11.9	8,289	.141	1.3
Clerical and kindred	23.5	13,714	.171	4.0
Sales workers	5.2	4,854	.106	3.9
BLUE COLLAR				
Craftsmen, foremen, and kindred	29.4	10,158	.289	3.8
Operatives	49.7	13,909	.357	7.1
Laborers, except farm and mines	6.3	3,724	.169	9.5
SERVICE WORKERS	8.6	9,712	.088	5.3
FARMERS AND FARM WORKERS	4.2	3,124	.133	2.6
TOTALS	160.3	78,627	.203	4.9

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[7] The short-run impact study produced a vector of job loss effects by industry, $[\Delta L_i]$. To find the effect of this job loss by skill categories, this vector was pre-multiplied by a matrix $[S_{ij}]$, where each entry measured the percentage of 1970 employment in industry i in skill class j.

[8] A very similar pattern of results emerged when the same calculations were carried out for the remaining years in the 1966–73 period for which we have data.

[9] In the interest of space, we have not reported the results of similar computations we made for a thirty-order occupational breakdown.

have argued that multinationals tend to export production activities to overseas sites while concentrating management and other front office support activities in domestic sites. (See, e.g. [8, 18].) If so, our estimates in Tables 2 and 3 will tend to understate the increase in structural imbalances in the labor market that result from capital outflows. On the other hand,there is some indication that the firms most heavily involved in foreign investment activities may employ production processes that are more technology intensive than those employed by other firms. If so, and if such technologies are relatively intensive in their requirements for skilled labor categories, our estimates will tend to overstate the occupational labor demand imbalance associated with DFI.

Finally, all of the occupational employment demand reduction estimates are based on our earlier estimates of the home-foreign substitution ratios and accordingly are subject to the same qualifications that apply to these.

With these qualifications in mind, our estimates of the occupational employment demand effects of DFI provide no support for the hypothesis that the desire to escape domestic labor market bottlenecks is the primary motive for the establishment of foreign subsidiaries by MNCs. On the contrary, our estimates seem to suggest that foreign investment is if anything a cause rather than an effect of domestic labor market bottlenecks.[10] To be sure, DFI is not the only cause of such bottlenecks and the magnitudes of the effects we estimate are small enough to suggest that the problem of poorly distributed demands in the labor market would be with us for quite some time even if new foreign investments were prohibited altogether.

3. Short-Run Labor Market Adjustments to Unemployment Resulting from Overseas Production Transfers

In this section we employ a simple probabilistic model of the labor market in an attempt to simulate the time profile of industry unemployment as it responds to an initial DFI-related displacement of workers.

Previous discussions of the effect of DFI on unemployment have produced estimates of the total number of jobs lost by cumulating the equivalent of our employment demand reduction estimates for a rather lengthy historical period. The U.S. Tariff Commission, for example, has estimated [18] that as many as 1.3 million jobs may have been lost because of the cumulative effects of foreign investment through 1970. Estimates such as these shed very little light on the question of how much of our current domestic unemployment is the result of DFI. Most workers who lost their jobs when plants moved abroad during the mid-sixties have presumably either retired, died, or found new jobs in the meantime. Accordingly, explicit account of labor market adjustment processes must be taken in order to generate even a crude picture of the actual unemployment that results from overseas investment.

Contemporary discussions of the problem of unemployment have stressed its dynamic character. The flows in and out of unemployment are very substantial in relation to the stock of unemployed individuals and spells of unemployment are of short average duration. A certain degree of job turnover is inherent in the normal functioning of any labor market. Even in equilibrium we usually observe simultaneously a group of unemployed job seekers and a collection of unfilled job vacancies. Under given institutional conditions, the likelihood that a job seeker will be placed in a job during a certain time period will depend on the overall balance between those vancancies and searchers. In an expanding sector in which vacancies greatly outnumber searchers, the likelihood of a rapid placement is high, and vice-versa.

In our exercise, we consider a situation in which each industry labor market is in an initial state of equilibrium such that vacancies and searchers are approximately in balance. The first impact of overseas production transfers for a given industry is taken to be the addition to the unemployed pool of a group of workers. Their number is determined by the size of the export displacement effect for that industry, as described in section 1. Simultaneously, the industry adds vacancies due to the export stimulus effect, also described in section 1. Because the export displacement effect outweighs the export stimulus effect for every industry in our study, the outcome of these additions is to increase the ratio of unemployed job seekers to unfilled vacancies. This, in turn, reduces an individual searcher's probability per period of successful job placement. We employ this reduced placement probability to estimate the number of searchers who will find jobs during the next period.

The normal turnover process is presumed all the while to generate flows of new searchers and vacancies each period. These flows are used in conjunction with the estimated placement outcomes from the previous period to determine a new placement probability for the next period. The same calculations are then performed for successive periods until most of the originally displaced workers have secured new jobs. Once most of these placements have occurred, the labor market will have moved to a state in which the flows into and out of unemployment are again equal. Even though the flow balance is restored, the stock of job seekers will continue to be larger than the stock of vacancies until aggregate policies can restore demand or until a fall in wages can restore labor market equilibrium. As a result, the probability per period of successful job placement will be less than it was originally, even after all of the workers displaced by the production transfer have found new jobs.

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[10] This interpretation is consistent with the widely held belief that multinationals go abroad primarily because of the multiple cost advantages of locating production facilities in close proximity with the markets they serve.

Our model thus points to two types of unemployment that are attributable to overseas production transfers. The first and most visible of these is the initial spells of joblessness experienced by those workers directly displaced by the production transfers. The second and somewhat more subtle type results from the fact that the employment demand reductions reduce placement probabilities for all job seekers, so that even those not displaced directly by the production transfers will take longer on average to secure new jobs.

On the basis of a model of this type, we have estimated adjustment profiles for the initially displaced workers in eight large manufacturing industries.[11] These estimates are reported in Tables 4 and 5. Row 1 of Table 4 records the number of layoffs (in thousands) associated with the 1970 export displacement effect for each industry. Successive rows of Table 4 list our estimates of the number of these initially displaced workers who remain unemployed on successive weeks from the layoff date. Table 5 translates the entries of Table 4 into proportional terms; its *i*th row entries are interpreted as the fractions of the originally displaced cohorts that remain unemployed *i* weeks from the layoff date.

The most striking feature of the estimates reported in Tables 4 and 5 is that, for each industry, a majority of the displaced workers will have found new jobs within seven weeks of the date of the onset of their unemployment. The nonelectrical machinery industry, which experiences the largest initial job displacement, also exhibits the most seriously persistent unemployment problems, but even in this case more than 80 percent of the initially displaced workers will have found new jobs within fourteen weeks of their layoff dates. Thus, the unemployment profiles in Tables 4 and 5 suggest that protracted periods of joblessness are not one of the major costs associated with the transfer of production activities overseas.

In Table 6 we summarize our estimates of the indirect unemployment that results from DFI. Columns 1–4 of Table 6 report weekly job placement probabilities by industry and the corresponding average unemployment durations both before the 1970 DFI displacement occurs and again after the initially displaced workers have found new jobs. Column 5 reports residual unemployment by industry, which is the increase in the stock of unemployed workers associated with the higher average durations of unemployment resulting from DFI related reductions in labor demand.

As it was in the case of direct unemployment effects, the nonelectrical machinery industry is hardest hit with respect to indirect effects. Its average duration of unemployment rises by more than 40 percent because of the employment demand reductions stemming from 1970 DFI. Even after those workers directly displaced by DFI have found new jobs, this higher duration of unemployment results in an increase of more than 40,000 in the nonelectrical machinery industry's stock of unemployed job seekers. The indirect effects are markedly smaller in all the other industries but are

Table 4
Direct Unemployment Resulting from 1970 Vector Initially Displaced Workers Who Remain Unemployed (Thousands)

	Industry							
Weeks from layoff date	Food	Paper	Chem	Rubber	Metal	Mach	Elec Mach	Trans Equip
1	8.3000	9.3000	18.0000	7.6000	27.4000	53.9000	24.9000	14.4000
2	6.3160	7.5529	15.6094	6.2345	22.2453	47.4677	21.5880	12.2774
3	4.8079	6.1430	13.5481	5.1180	18.0667	41.8344	18.7230	10.4689
4	3.6609	5.0023	11.7677	4.2039	14.6775	36.8936	16.2431	8.9277
5	2.7881	4.0772	10.2277	3.4547	11.9270	32.5548	14.0953	7.6140
7	1.6178	2.7144	7.7375	2.3358	7.8802	25.3836	10.6211	5.5393
10	0.7156	1.4796	5.1055	1.3011	4.2362	17.5240	6.9560	3.4386
15	0.1839	0.5409	2.5650	0.4921	1.5076	9.4956	3.4431	1.5543
20	0.0473	0.1984	1.2931	0.1865	0.[illegible]370	5.1657	1.7070	0.7028
25	0.0122	0.0730	0.6534	0.0708	0.1913	2.8182	0.8472	0.3179

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[11] For details of the procedures and data sources used, see Appendix 1.

Table 5

Direct Unemployment Resulting from 1970 Vector Percentage of Initially Displaced Workers Who Remain Unemployed, 1970

Weeks from layoff date	Industry							
	Food	Paper	Chem	Rubber	Metal	Mach	Elec Mach	Trans Equip
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.7610	0.8121	0.8672	0.8203	0.8119	0.8807	0.8670	0.8526
3	0.5793	0.6605	0.7527	0.6734	0.6594	0.7761	0.7519	0.7270
4	0.4411	0.5379	0.6538	0.5531	0.5357	0.6845	0.6523	0.6200
5	0.3359	0.4384	0.5682	0.4546	0.4353	0.6040	0.5661	0.5288
7	0.1949	0.2919	0.4299	0.3073	0.2876	0.4709	0.4266	0.3847
10	0.0862	0.1591	0.2836	0.1712	0.1546	0.3251	0.2794	0.2388
15	0.0222	0.0582	0.1425	0.0647	0.0550	0.1762	0.1383	0.1079
20	0.0057	0.0213	0.0718	0.0245	0.0196	0.0958	0.0686	0.0488
25	0.0015	0.0078	0.0363	0.0093	0.0070	0.0523	0.0340	0.0221

nonetheless substantial in several, especially electrical machinery and chemicals.

At the micro-level the residual unemployment increases constitute a smaller social burden than might at first appear, inasmuch as these are the result of a small increase in the average duration of a spell of unemployment of roughly one week. On the other hand, when viewed in terms of their implied costs in output forgone, the residual unemployment figures appear much more significant.

Like the direct unemployment effects, the residual effects are a transitory phenomenon; they will tend to decay as real wages adjust and as the employment demand reductions from which they stem are offset by aggregate demand policy. How long these effects will take remains an open question.

In interpreting the findings reported in Tables 4, 5, and 6, one should bear in mind that the estimates of the size of the initial displacements are rather more uncertain than are those of the indirect effects as noted in Appendix 1. We also stress that any conclusions that may be drawn from the analysis above will be applicable only to labor markets whose degree of tightness is roughly the same as in 1970. Particular care should be taken to avoid any inference that our estimates are indicative of what the time profiles of DFI-related unemployment would be like in the 1976 labor market with its nearly 8 percent unemployment rate.

4. The Long-Run Distributional Consequences of Overseas Investment

Up to this point our study has been primarily microeconomic in its approach. The analysis of the labor market dislocations due to DFI has been based on firm, industry, and labor market behavior. Although this focus is appropriate for shorter run issues, it is less

Table 6

Indirect Unemployment Resulting from 1970 DFI Vector

Industry	Weekly Placement Probability		Average Duration of Unemployment (Weeks)		Residual Unemployment
	Pre-1970 DFI	Post-1970 DFI	Pre-1970 DFI	Post-1970 DFI	
Food	0.253	0.239	3.95	4.19	6,403
Paper	0.236	0.185	4.24	5.42	6,967
Chemicals	0.182	0.130	5.49	7.72	14,562
Rubber	0.203	0.178	4.93	5.62	4,721
Metals	0.198	0.187	5.04	5.35	8,388
Nonelectrical machinery	0.164	0.116	5.91	8.65	41,708
Electrical machinery	0.151	0.132	6.62	7.58	16,557
Transportation equipment	0.153	0.147	6.54	6.80	6,449

pertinent when the relevant time horizon is extended, since the aggregate economy can eventually adjust to dislocations caused by DFI through either market forces or direct policy intervention.[12] Thus, when considering the long-run consequences of foreign investment, emphasis should be given to its effects on the general wage level, national income shares, and aggregate output, rather than on the details of temporary job losses. The change to a broader, long-run frame of reference simplifies the analysis in some respects, but it also introduces some new issues that could safely be ignored in the more microeconomic approach. For example, a long-run study must deal with a more generalized notion of factor substitution. In this regard there are two types of substitution possibilities that need to be distinguished: substitution between foreign and domestic investment (i.e., the aggregate counterpart of the microeconomic home-foreign substitution issue discussed earlier) and substitution between domestic factors of production. Both have a bearing on such questions as the effect of foreign investment on domestic wages. To the extent that overseas investment substitutes for domestic investment the equilibrium U.S. capital stock will be smaller and, therefore, home wages lower when foreign investment is allowed than would be the case if it were prohibited. Similarly, when capital and labor can be substituted freely for one another in domestic production processes, a large decrease in the home capital stock from foreign investment will have a relatively small impact on wages.

In addition, in both cases the concept of substitution applies to a very highly aggregated view of the economy. Thus, the measure of domestic factor substitution must implicitly take into account all the underlying compositional changes and adjustments that bring domestic factor and product markets to equilibrium. Likewise, the aggregate home-foreign substitution concept should allow not only for substitution within the multinational firm but also for more general induced effects in domestic and international markets.

A number of estimates of aggregate domestic factor substitution in U.S. production have been made, but, as was the case in the microeconomic studies discussed earlier, almost no evidence exists on the long-run aggregate substitution between home and foreign investment. Although this issue is obviously of central importance, most past analyses have bypassed the question — sometimes without explicit indication — and instead used assumed values for key substitution parameters. In the analysis that we report here, we have attempted to provide indirect estimates of the size of this substitution effect by inference from observed data.

The basis for these estimates is a highly aggregated model of the world economy, in which we have tried to preserve the most relevant macroeconomic features of an ongoing overseas investment program.[13] In particular, we have found it convenient conceptually to divide global production into three main sectors, each with its own distinct production function. These sectors are (1) a home sector (in which home labor and home capital are the main inputs to production), (2) a foreign sector (in which foreign labor and foreign capital are the inputs), and (3) a foreign investment sector (in which *home* capital and *foreign* labor are the inputs). To simplify matters, production relationships in each sector are taken to be of the same general form. They differ from one another, however, by scale factors that are chosen to reflect differences in productivity, systematic differences in local costs (not fully offset by other factors), or the impact of local commercial policy. Irrespective of the underlying causes of these differences, they are similar in their effect on the location of production. If we assume that investors seek the highest after tax real return on their investment, it is obvious that foreign investment will be encouraged by a large technology or cost gap that favors use of home versus foreign capital and foreign versus home labor.

In this regard, the influence of capital-specific factors on foreign investment should be emphasized, since it has largely been ignored in formal treatments of the topic. In the conventional approach it is generally assumed that international technology gaps derive from local conditions and are associated with internationally nonmobile factors of production (which collectively correspond to "labor" in this context). Accordingly, nonlocal investors can take advantage of these gaps by an inward flow of capital. Investment for raw materials extraction provides a convenient illustration of this type. If all foreign investment were motivated by similar local factors, simply distinguishing between home and foreign production would probably be sufficient in an aggregate model. However, recent analysis has emphasized the importance of capital flows based on factors specific to the investor that are also transferable to the overseas site (see, e.g. [12]). The advantages may reside in access to a superior technology in the narrow, technical sense or they may depend on better management, successful product identification, or skillful marketing. Regardless of the underlying cause, the resulting DFI serves as a vehicle for extending this special advantage to a foreign site in order to capture its full value. To model this capital-specific aspect of foreign investment we have, therefore, added the foreign investment sector as a separate entity in which relatively high-powered U.S. owned capital is combined with local labor.

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[12] More specifically, these adjustment mechanisms include: (1) direct adjustment through wage changes in the affected industries, (2) indirect accommodation through exchange rate changes, differential rates of inflation, and induced changes in income, (3) general and specific domestic stabilization policies, and (4) offsetting international commercial policy measures, including tariffs, quotas, subsidies and special taxes, and regulations on DFI. Of course, this variety of possible adjustment mechanisms greatly complicates any analysis of the long-run adjustment process and its outcome.

[13] The details of the model are spelled out more fully in our "The Distributional Consequences of Direct Foreign Investment," research report submitted to U.S. Department of Labor, 1977 and in Appendix 2.

It is important to stress the point that when dealing with long-run issues foreign investment should be regarded as part of an ongoing, dynamic process. The reason that this needs emphasis is that it is quite common in some popular views to treat foreign investment as if it amounted to a physical transfer of units of capital across international boarders. In these views, the foreign capital stock is augmented by DFI and the domestic capital stock is reduced in a simple one-for-one fashion — just as if the corresponding physical machinery were unbolted and reinstalled across the border. In making such a simplification, however, this approach predetermines the answer to an important and controversial question — namely, the degree to which foreign investment substitutes for home investment.

More plausibly, real foreign investment takes place as new capital goods are purchased by foreign subsidiaries from the output streams of both the host and home economies. These investment goods provide new capital inputs for production in subsequent periods. Hence, a full analysis of long-run equilibrium must take into account not only the current period's international allocation of capital but also its effect on the continuous process of savings, investment, and output growth. Only after the true long-run equilibrium is determined can we measure the complete effect of foreign investment on concepts of particular interest — including the degree of home-foreign substitution in the capital stock. As we shall see, when these dynamic effects are introduced, the degree of home-foreign substitution can vary over a rather wide range and is by no means confined to a value of unity.

It may be helpful at this point to summarize briefly the mechanics of the model we have in mind. When direct foreign investment is first allowed, U.S. firms respond to the opportunity for greater profits by investing in foreign operations. The initial transactions are financial, but we assume that the real counterpart eventually takes place as well. When this shift has been accomplished, ordinarily more capital will be installed overseas, and, to a degree, less at home. The effective transfer of real capital implies that foreign wages will be driven up in both the foreign sector and the foreign investment sector, and home wages will be reduced. Domestic tax collections will also decline. In addition, domestic income levels and aggregate saving will be affected. Assuming that saving is positively related to income, if DFI raises total national income, then the rate of net capital formation will be increased accordingly. However, since these new contributions to the capital stock will alter rates of return, further rounds of adjustment are needed to reach equilibrium.

This dynamic process of adjustment will terminate only after several conditions are met. First, U.S. firms will continue to shift toward foreign investment activities until foreign and domestic (after-tax) rates of return to U.S. capital are brought into alignment. Likewise, wage levels in the DFI and foreign sectors must be equalized, since those two sectors share a common labor market. Finally, the rate of net capital formation (as determined by savings and, hence, by income) must eventually be in balance with the growth rate of the labor force, adjusted for productivity changes. Too rapid a growth in the capital stock will drive the aggregate marginal product of capital down, eventually producing a slower growth of output and of the capital stock itself. An initial rate of growth of capital that is too low will have the reverse effect.[14]

Our experiment is the opposite of the one described above — that is, we currently observe a world in which DFI is already permitted, and we seek to reconstruct what would have happened had DFI been restricted by inferring the long-run equilibrium to which the economy would tend.

Before turning to our estimations, several comments should be added regarding the role of government policy and the nature of the foreign sector in the model. Government activity influences foreign investment in several ways. First, tax policy with respect to profits from domestic and overseas investment directly affects the global allocation of capital and alters the flow of income and savings. Taxes levied on foreign investment earnings are also part of the government's total tax revenues. In addition, by its domestic fiscal activities the government can contribute to aggregate savings to the extent that net tax revenues exceed government consumption expenditure. In our estimations the specification of foreign investment taxes was based on current U.S. tax policy in which a credit is allowed for foreign taxes paid up to the full amount of the U.S. tax. The size of the government surplus or deficit was imbedded in the choice of an aggregate savings propensity, which in this case was based on historical values. This procedure, of course, ignored some possibly important compositional aspects of the savings and investment process that could be captured in a more detailed version of the model.

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[14] These arguments are based on a slightly extended version of the simple single-sector Solow growth model for a closed economy. At the point of dynamic equilibrium the economy's gross savings and investment (including foreign investment) will offset depreciation of the current capital stock (again, including foreign invested capital) and match (in percentage terms) any growth of the labor force and increase in its productivity. This equilibrium is stable in the sense that if the aggregate economy is dislodged from this point, it will automatically tend back toward this configuration. For more details on this type of growth model, see [20].

To reach any determinate outcome in the model it is also necessary to specify the economic behavior of the host country. In this area we have tried to strike a practical balance between realistic assumptions and the need to keep the model concise. Foreign investment earnings are assumed to be taxed abroad at a fixed proportional rate. In addition, savings policies are pursued in the foreign country that result in a stable long-run foreign capital-labor ratio (i.e., the ratio of capital *owned* by foreigners to the foreign labor supply). We recognize that other assumptions — such as a fixed foreign savings propensity — are legitimate alternatives to this specification, but an assumption of the latter type leads to the unnecessary complexities of a full-fledged two-country model.[15]

Finally, in our basic model we have followed the classical view that in the long run the current account — i.e., net exports plus net earnings on overseas investment — must be in balance. However, it is possible to allow for an imbalance in the steady-state equilibrium by an appropriate change in the aggregate propensity to save. This situation could arise, for example, if the United States were assigned the role of supplying dollar transactions balances to the rest of the world, as was the case in the late fifties and sixties. Any persistent current account deficit, of course, acts as an additional source of savings to the aggregate economy.

Estimates of Long-Run Effects

One of the attractive features of a highly aggregated model is that it requires relatively few pieces of outside information. The other side of this "advantage," however, is that results tend to depend closely on the specification of relationships and parameters. In this regard it is sufficient to point out here that relatively reliable values for many of the basic parameters are available in published sources. For several others, however, we have had to supply our own estimates; in this case we have also experimented with variations around these values to check the sensitivity of conclusions to their assumed values. Perhaps the most uncertain are the parameters that measure the size of the technology and cost gaps across the three sectors of the global model. These parameters are important, inasmuch as they provide the basic motive for DFI, and empirical evidence on their values is particularly limited and of dubious quality.

We have proceeded by choosing parameter values for the technology and cost gaps that result in an equilibrium level of overseas investment that is in accord with observed historical levels. In doing so we have taken note of the fact that in the early 1970s the average reported net return from foreign investment was somewhat higher than that from domestic investment.[16] Although reported foreign profits may have been somewhat inflated for tax purposes, we have assumed that foreign investors in our base year of 1970 required approximately a 25 percent premium on the return to foreign invested capital. Then, relying on the fact that in 1970 the stock of foreign invested capital was approximately 6 percent of the total U.S. owned capital stock, we found the technology parameters that produced this capital stock ratio in the steady state.[17]

In Table 7 we present the results from three alternative experiments that measure the effect of DFI on the size and composition of national income. The estimates in row 1 are calculated on the basis of the 25 percent rate of return difference described above. Thus, the entries indicate in percentage terms the change in equilibrium income levels and shares that would have occurred had foreign investment been prohibited in 1970. These values are also used as our base values in the sensitivity tests reported in Appendix 2, Table A-1. It may be argued, however, that in 1970 the adjustment process might not yet have been completed and that as time passed the required premium on foreign investment earnings would have declined. These results thus constitute an unduly conservative view. Accordingly, for comparison we also show in rows 2 and 3 the outcome

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[15] Some experiments with a fixed savings rate in a two-country model indicate that approximately the same results can be obtained. Also, sensitivity tests on the choice of foreign capital-labor ratio show that our results are fairly stable over a reasonable range of values.

[16] Estimates of the rate of return on domestic and foreign investment vary and are somewhat uncertain due to both conceptual differences and reporting errors. We have used the figures appearing in [13, chap. 10] as a best approximation.

[17] The capital stock concept in this calculation is intended to include the entire privately owned capital stock of the United States — i.e., property, plant, equipment, and inventories of the corporate, unincorporated, and household sectors (excluding consumer durables). The 6 percent figure was derived by first using the figures for all industries in [13, Table 2–4, cols. (2) and (4)] for domestic and foreign fixed assets. Foreign assets were expanded by allowing 25 percent for foreign inventories, and domestic assets were expanded to the broader definition of capital stock by applying the proportions given in [3, p. 301]. If a narrower definition of the capital stock were used (on the assumption, for example, that there is relatively little factor substitution between the corporate sector and the rest of the economy) the 6 percent stock ratio should be increased and the effect of DFI on domestic incomes in the corporate sector would be larger.

Table 7

Long-Run Effects of Direct Foreign Investment

	1 Equilibrium Ratio of Foreign Subsidiary Capital Stock to Domestic Capital Stock	2 Change in U.S. Wages (percent)	3 Change in Labor's Share of National Income (percent)	4 Change in U.S. Rate of Return (percent)	5 Change in U.S. National Income (percent)	6 Home Foreign Substitution Ratio
1	0.062	−3.2	−1.7	6.2	−0.6	1.099
2	0.098	−5.3	−2.7	10.5	−2.7	1.123
3	0.219	−13.1	−5.9	28.1	−4.4	1.208

Note: The estimates in Table 7 were computed using methods and parameter values described in the technical appendix to this section. Row 1 assumes that foreign investment requires a 25 percent premium; row 2, a 20 percent premium; row 3, no premium. National income, as it is used here, is a gross concept and includes overseas earnings net of foreign taxes.

when the premium is reduced to 20 percent and zero, respectively. As one would expect, the percentage changes in rows 2 and 3 are absolutely larger than corresponding entries in row 1, but are always in the same direction.

In all cases DFI produces a decline in both the real wage (column 2) and the share of national income going to labor (column 3), when compared with a no-DFI regime. The reduction in labor income is substantial for rows 2 and 3, and reflects the fact that the domestic capital stock is appreciably larger in the no-DFI regime than in a regime in which DFI is permitted. Even by the relatively conservative estimates in row 1, however, wage income is reduced by more than 3 percent. On the other hand, income accruing to capital (pre-U.S. tax, but post-foreign tax) increases significantly in all cases. This is hardly surprising, since higher return abroad is presumably the original motive for DFI.

The fact that labor's *share* of income (column 3) declines less rapidly than the *level* of labor income (column 2) may seem paradoxical at first. A partial explanation lies in the fact that national income *declines* under the DFI regime — in row 1 by 0.6 percent. This observation itself may be somewhat surprising in light of one's usual expectation that a freer movement of factors of production should ordinarily result in a more efficient allocation of resources and higher aggregate income.

The final answer is found in the large dead-weight loss to the home economy caused by tax payments to foreign treasuries. Overseas investors care about the total tax assessed on overseas earnings, but may be presumed to be indifferent to the nationality of the tax collector. The home treasury, of course, is not. Current U.S. tax law allows a full credit for foreign taxes paid; under present foreign and domestic tax rates the result is that over 90 percent of taxes paid on foreign subsidiaries' earnings go to foreign treasuries. According to our calculations, this large loss apparently more than outweighs any gains to investors taken collectively. This possibility of overinvestment by U.S. firms has been suggested elsewhere (e.g., [13]), and this exercise provides some additional support to the argument that higher total taxes on overseas earnings could raise aggregate U.S. welfare.

From the equilibrium values of the model it is also possible to obtain an estimate of the long-run version of the home/foreign substitution ratio used in the earlier short-run study. Recall that this ratio measures the extra capital stock that would have been retained at home had DFI been disallowed, expressed as a fraction of the actual stock of capital invested overseas. The long-run version of this substitution ratio, shown in column 6 of Table 7, turns out to exceed 1.0 in every case. This means that in the long run, for every dollar's worth of capital stock invested overseas, *more* than one dollar's worth would have been invested at home had DFI been prohibited. The explanation of this somewhat counterintuitive result is related to our earlier observation that under DFI, total home income declines. When DFI is not allowed, home income rises; increased income will provide extra savings and extra investment, *all of which* will be retained in the domestic economy. The consequence is a larger than unitary shift in the long run.

The results of the sensitivity tests displayed in Appendix 2, Table A-1 are also worth brief comment, since they give some indication of how these conclusions would be affected by changes in the basic parameters of the model. Several parameters appear to have only a rather minor effect on the long-run equilibrium; they include the foreign and home tax rates (rows 2 and 3) and the parameters that measure the relative size and capital-intensiveness of the foreign sector (rows 7 and 8). On the other hand, the results appear to be considerably more sensitive to the parameters of the production function (rows 9 and 10), and especially to the technology parameters (row 5), suggesting the need for further refinement of the production data.

The rather strong influence of the tax rate applied to foreign earnings is also worth pointing out, since the tax treatment of foreign investment has been the focus of much recent debate. In one experiment we reduced the total tax on foreign investment earnings to equal the foreign tax level (holding the U.S. tax rate at constant); this is equivalent to a regime in which U.S. foreign investment earnings are subject to an indefinite deferral on payment of U.S. taxes. In this case the percentage difference in wages rises to almost 5 percent, and the net loss of national income exceeds 1 percent when DFI is allowed.

Finally, as might be expected in a long-run growth model, the results are rather sensitive to the assumed growth rate. By implication they are also sensitive to the rate of depreciation and rate of growth of the labor force, since these parameters play a similar role in the model. It has been suggested that the domestic savings propensity, rather than being constant, might be responsive to changes in the domestic interest rate, and that foreign investment might thereby contribute to economic growth by indirectly stimulating savings. Some preliminary experiments that allow for a positive association between savings and the interest rate indicate that, even under extremely high interest elasticities, the qualitative results obtained earlier are unchanged. However, it still may be the case that a sufficiently strong association between foreign investment and savings — for example, if foreign earnings were almost entirely retained and reinvested — could reduce the income losses cited above. Further investigation in a more disaggregated model is needed in order to evaluate this possibility.

In general, the results in this section are consistent with and support the findings in the earlier part of this study. It appears that foreign investment has brought about a moderate decline in both wage rates and labor's share of total national income. At the same time there appears to have been a slight overall loss in total income accruing to the U.S. economy, primarily because of large tax payments on foreign earnings that are collected by foreign treasuries under the current tax system. It is important to point out that, although the numbers that we have generated in this section are indicative of the scale and direction of these effects, they should be regarded at this point as tentative estimates only. As we have already emphasized, the results depend to a considerable extent on the values assigned to several key parameters. This sensitivity suggests that future research should be directed particularly at upgrading the quality of these inputs to the estimation.

Appendix 1

The Industry Labor Market Model

For a single industry labor market we employ the following notation:

t = separations rate, exogenously determined
a = accessions rate
p = probability a job seeker secures employment in a given period
d = expected duration of a spell of unemployment
U = number of unemployed workers in the industry
V = number of job vacancies in the industry
E = number of employed workers
J = total demand for labor = $E + V$
L = labor force = $E + U$
W = the money wage rate
$\dot{W}/W$ = the rate of wage inflation = $g\ (V/U)$, with $g' > 0$.

The probability that a job seeker secures employment in a given period is assumed proportional to the number of vacancies per job seeker in the industry

$$p = \begin{cases} kV/U, \text{ when } V/U < 1/k; \\ 1, \text{ when } V/U \geqslant 1/k, \end{cases}$$

where $0 < k \leqslant 1$.

The probability that a given job seeker secures employment only after T periods of search is equal to $p(1-p)^{T-1}$. Thus, the expected duration of a spell of unemployment is given by

$$d = \sum_{T=1}^{\infty} T\, p(1-p)^{T-1} = \frac{1}{p}.$$

The accessions rate, i.e., the number of job seekers who secure jobs each period as a fraction of total employment, is given by

$$a = kV/E.$$

The following conditions define complete equilibrium in the industry labor market:

$$U = V,$$
$$t = a.$$

(Alternatively, the number of vacancies created each period tE must be the same as vacancies filled kV).

We shall also consider the possibility of less than complete equilibrium configurations, a "semi-equilibrium," in which

$$U > V, \text{ but } t = a.$$

Eventually, in this situation, the Phillips relation $\dot{W}/W = g\,(V/U)$ will produce falling wages, bringing V back into balance with U. As a practical matter, however, wages may be very slow to fall in response to an excess of searchers over vacancies and, moreover, industry labor demand may be highly wage inelastic, making possible a protracted excess of U over V. The existence of such reasonably stable disequilibrium configurations, first rationalized by Keynes in terms of wage rates being "sticky downwards," has received considerable empirical documentation in recent years and increasingly has come to be interpreted in terms of quantity rates of adjustment strongly dominating price rates of adjustment when markets are displaced from equilibrium.

Our simulation exercise considers the industry labor market to be in an initial equilibrium configuration of the complete type. This initial equilibrium is disturbed by industry direct foreign investment activities that simultaneously displace ΔU existing jobs and create ΔV new jobs, the immediate effect of which is to increase the stock of unemployed workers from U to $U + \Delta U$ and the stock of vacancies from V to $V + \Delta V$.

These changes in the vacancy and unemployment stocks produce an immediate change in the probability of placement and, hence, in the duration of an unemployment spell from d to d_1, where

$$d_1 = 1\Big/\frac{k(V + \Delta V)}{(U + \Delta U)}. \qquad (1)$$

Expression (1) illustrates the importance of keeping separate accounts for both job gains and job losses when assessing the dislocative effects of a shift in labor demand. Most studies of the effects of DFI on domestic employment have instead placed primary emphasis on the net job displacement figure, i.e., $(\Delta U - \Delta V)$ in our notation. Using expression (1), it is a simple matter to demonstrate that a job displacement of $(\Delta U - \Delta V)$ jobs produces a smaller increase in the duration of unemployment than does a job loss of ΔU accompanied by a not fully offsetting job stimulus ΔV. Moreover, emphasis on the net job displacement figure tends to obscure the fact that ΔU, not $\Delta U - \Delta V$, individuals are initially added to the stock of job searchers as a result of the labor demand shift.

If the DFI-related labor demand shifts result in more workers being displaced than there are new job vacancies created, as we have estimated they do for each of the industries in our study, the duration of a spell of unemployment is seen from expression (1) to rise initially.

We assume that wages in this case are slow to respond and/or that industry labor demand is insensitive to wage rates; the industry labor market then proceeds to establish a semiequilibrium of the type discussed above, in which the flow of accessions equals the flow of separations, but in which the stock of searchers persists at a higher level than the stock of vacancies. This semiequilibrium position is formally defined by

$$tE^* = kV^* \qquad (2)$$

where the starred variables represent values taken in the semiequilibrium position. V^* and E^* are also related by

$$E^* + V^* = J^*, \qquad (3)$$

where

$$J^* = E + V - \Delta U + \Delta V = J + \Delta J.$$

Solving (2) and (3), we obtain

$$E^* = \frac{kJ^*}{t+k} = E + \Delta J\,\frac{k}{t+k}$$

and

$$V^* = \frac{tJ^*}{t+k} = V + \Delta J\,\frac{t}{t+k}\,.$$

Since the labor force has remained unchanged we also have

$$U^* + E^* = U + E$$

or

$$U^* = U + (E - E^*) = U - \Delta J\,\frac{k}{t+k}\,.$$

The probability of job placement in the semiequilibrium is then

$$p^* = \frac{kV^*}{U^*} = \frac{k[V + \Delta J(t/(t+k))]}{[U - \Delta J(k/(t+k))]}\,,$$

which yields a corresponding unemployment duration of

$$d^* = 1/p^*.$$

We compare the values of the original equilibruim duration of unemployment d, its initial disturbance value d_1, and the semiequilibrium duration d^* when $U = V$ and $\Delta U > \Delta V$ and find

$$d < d_1 < d^*.$$

Or, in placement probability terms

$$p > p_1 > p^*.$$

As long as the duration of unemployment remains higher than its initial value following a DFI-related disturbance, all workers who enter the pool of job seekers, whether because of a DFI displacement or not, can expect to experience a longer spell of unemployment than they would have in the absence of the disturbance. Put another way, there will continue to be more men unemployed, on the average, than there were originally, even well after most of the initially displaced workers have secured new jobs. In terms of the semiequilibrium position described above, there will be U^* men unemployed each period as compared with the initial equilibrium value U. The difference,

$$U^* - U = -\Delta J\left(\frac{k}{t+k}\right) = -(\Delta V - \Delta U)\left(\frac{k}{t+k}\right), \quad (4)$$

we will label the residual contribution to industry unemployment of the DFI-related disturbance. This residual contribution will persist as long as the semiequilibrium condition persists; that is, until falling wages, a sectoral product demand shift, aggregate policies, or some other phenomenon occurs so as to reestablish the industry balance between vacancies and unemployment.

Data Sources for the Simulation Exercise

The year 1970 was chosen for our simulation exercise because the overall unemployment rate of 4.9 percent during that year approximates the "full employment" level characteristic of contemporary macroeconomic policy discussions.

Employment and Earnings publishes data for employment, unemployment, and separations rates for most important manufacturing industries at the level of aggregation corresponding to our employment demand estimates reported in section 1. For a year in which industry labor markets are in equilibrium as defined in our model, initial industry unemployment durations can be calculated by exploiting the equilibrium relation,

$$u_i = t_i \times d_i,$$

where u_i is the ith industry unemployment rate, t_i is the separations rate (separations per month per 100 employees) and d_i is the average duration per spell of unemployment, measured in months.

For the year 1970, a year of increasing unemployment, such a procedure would not be entirely appropriate, since the recorded separations rates for most industries exceed those required to generate equilibrium unemployment stocks at 1970 values. We make an adjustment for this problem by adopting as our estimates of industry equilibrium separations rates the arithmetic means of the published values for separations rates and accession rates. The latter figures, in contrast to the separations rates, are *lower* than those corresponding to equilibrium vacancy — unemployment stocks in a year of rising unemployment. This adjustment is somewhat crude and inexact, but the general pattern of results produced by our procedure is fortunately not very sensitive to minor inaccuracies in the measurement of industry separations rates.

Finding d_i enables us to calculate the corresponding placement probability p_i, and, again exploiting the equilibrium assumption, the proportionality factor k_i in the placement probability expression.

Our first calculations in the simulation exercise trace the placement probability movements from p_1 to p^* in weekly intervals and employs these values to compute time profiles of the number of DFI-displaced workers who remain unemployed in each industry. These are the "direct unemployment effects" summarized in Tables 4 and 5. The properties of the semiequilibrium are summarized as "indirect unemployment effects" in Table 6.

When interpreting the results reported in Tables 4–6, several qualifications should be borne in mind.

As the exercise was set up, all of the dislocations resultant from both the direct and indirect effects of the 1970 DFI vector were presumed to have occurred all at once. One might easily argue that, at the level of industry aggregation of our study, DFI effects would be better characterized as occurring in a smooth flow throughout the year. The effect of such a characterization is to replace the large groups of unemployed workers whose experience we trace in Tables 4 and 5 with many smaller groups. The unemployment profiles of these smaller groups will be very much like those of the larger groups and, as the DFI accumulates to its yearly total, the residual unemployment contribution under the smooth flow view becomes identical with its lump sum approach counterpart.

Actual implementation of our model required first that certain assumptions be made concerning the nature of the export displacement and export stimulus effects discussed in section 1. If the foreign investment project is preceded by a complete shutdown of the domestic production facility, whereupon a domestic operation is reorganized to serve the export requirements of the foreign production site, the number of initially displaced workers is determined by size of the export displacement effect, and the number of new vacancies will be determined by the size of the export stimulus effect. On the other hand, if the U.S. export requirements of the overseas production site are satisfied by simply retaining some portion of the domestic production operation intact, the number of initially displaced workers is determined by the difference between the export stimulus and export displacement effects, whereas the number of new vacancies would be zero. The actual mix of these two assumptions that best characterize the industries in our study would be quite difficult to estimate precisely. For the purposes of our calculations in this section we have assumed the maximally dislocative alternative, namely that U.S. export requirements of foreign production sites are served from newly organized domestic operations. In interpreting our findings, therefore, it should be kept in mind that our estimates of the number of initially displaced workers are, at least on this particular account, upward biased. Since the export stimulus is usually only a small fraction of the export displacement, however, this bias is probably very small.

A very similar qualification applies in the case when the overseas production transfer occurs in the context of a firm whose domestic employment is growing rapidly. For such firms, the export displacement effect may take the form of fewer new workers being hired rather than existing employees being discharged. If so, our estimates of the initially displaced workers will again be upward biased.

As far as the residual unemployment estimates are concerned, however, these depend only on the size of the net employent demand reduction (i.e., the difference between the export displacement and export stimulus effects) and will thus be affected neither by the particular assumptions made about whether the export stimulus effect requires the reorganization of domestic production facilities nor by the rate of growth of domestic employment demand.

In our model it was also assumed that industry labor markets were essentially independent of one another. In practice, however, we may witness substantial inter-industry migration on the part of job seekers, the effect of which would be to eliminate much of what limited heterogeneity is displayed in the collection of adjustment paths in Tables 4 and 5.

Appendix 2

The Long-Run Model

The following equations summarize the basic model used to determine equilibrium values:

$$\theta [k-e] - \theta \psi e_F - e^* [1 - \theta [1+\psi]] + [1-\theta] k^* = 0, \quad (1)$$

$$\theta \left[\frac{k(.1+\psi)}{e+\psi e_F} - 1 \right] + (1-\theta) \left[\frac{k^*}{e^*} - 1 \right] = 0, \quad (2)$$

$$f^*(e^*) - e^* f^{*\prime}(e^*) = f_F(e_F) - e_F f_F{}'(e_F), \quad (3)$$

$$f'(e) = \left[\frac{1-t}{1-\tau} \right] f'_F(e_F), \quad (4)$$

$$nk/\sigma = f(e) + [1-\tau^*] f'_F(e_F) [k-e], \quad (5)$$

where

k = capital/labor ratio for factors *owned* by the home country

k^* = capital/labor ratio for factors *owned* by the foreign country (assumed constant)

e = capital/labor ratio for factors *employed* in home production

e_F = capital/labor ratio for factors *employed* in the foreign investment sector

e^* = capital/labor ratio for factors *employed* in foreign production

$f(e)$ = output per unit of labor in home production

$f_F(e_F)$ = output per unit of labor in the foreign investment sector

$f^*(e^*)$ = output per unit of labor in foreign production

θ = ratio of home labor to total world labor (constant)

ψ = ratio of foreign labor employed in the foreign investment sector to labor employed at home

η = growth rate of the home labor force plus the rate of capital stock depreciation (constant)

σ = home average savings propensity (constant)

τ = home tax rate on domestic returns to capital (constant)

τ^* = foreign tax rate on foreign returns to capital (constant)

t = total tax rate (including both foreign and domestic taxes) on returns to foreign invested capital.

Table A-1
Sensitivity Tests

	Change in Wages (percent)	Change in Rate of Return (percent)	Change in National Income (percent)
1. Base values	−3.2	6.2	−0.6
2. $\tau^* = 0.35$ (down 12 percent)	−3.0	6.1	−0.4
3. $\tau = 0.48$ $t = 0.48$ (both up 12 percent)	−3.2	6.2	−0.6
4. $\tau = 0.43$ $t = 0.40$ (t down 7 percent)	−4.8	9.6	−1.1
5. $\lambda = 85$ $\mu = 1.18$ (change = 6 percent)	−7.7	15.7	−1.2
6. $k^* = 5.5$ (down 8 percent)	−5.2	10.3	−0.9
7. $\theta = 0.5$ (up 25 percent)	−2.7	5.1	−0.5
8. $\sigma = 0.16$ (up 7 percent)	−6.2	12.4	−1.0
9. $\omega = 0.43$ (down 16 percent)	−6.2	1.2	−1.0
10. $\rho = 0.6$ (down 20 percent)	−1.6	3.5	−1.1

Notes: Under a CES specification the wages and the home return to capital can be expressed as

$$w = \lambda \mu (1-\omega)(e)^{1/\rho}, \quad r = \lambda \mu (\omega)\left(\frac{f^*(e)}{e}\right)^{1/\rho}.$$

National income (per capita), defined to include the returns to capital invested abroad, is

$$y = w + r \cdot e + r_F (k-e)(1-\tau^*).$$

The share of labor in national income is, therefore, w/y, and capital's share is $1-(w/y)$.

The parameter values used in results reported in Tables 7 and A−1 are (unless otherwise indicated):

$A = 1.0$ $\eta = 0.05$
$\rho = 0.75$ ($\beta = 1/3$) $\tau = 0.43$
$\omega = 0.50$ $\tau^* = 0.40$
$\sigma = 0.15$ $t = 0.43$
$k^* = 6.0$ $\lambda = 0.90$
$\theta = 0.40$ $\mu = 1.10$

Production parameters (A, ρ, and ω) and tax levels (τ, τ^*, and t) are based on [13, chap. 9]. Derivation of the technology parameters (λ and μ) is described in the text. The aggregate propensity to save, σ, is based on annual data in various issues of the *Survey of Current Business*, and includes allowance for a 2 percent (of GNP) government budget deficit. The 5 percent figure for η is based on a 4 percent annual depreciation rate and 1 percent annual growth rate of the labor force. The capital-labor ratio estimate for the foreign sector, k^*, is assumed to be 10 percent lower than the corresponding steady-state figure for the U.S. The parameter θ is intended to be a rough measure of the relative size of the foreign corporate sector(s) in DFI host countries.

As may be seen, production is carried out in three locations: at home, abroad by home entrepreneurs (foreign investment), or abroad by foreign entrepreneurs. Each sector has its own production relationship and corresponding factor employment ratio. Equations (1) and (2) are full employment conditions, which require that the total world stocks of capital and labor, respectively, be fully utilized in the three sectors. Equation (3) indicates that, in equilibrium, foreign investors and local foreign producers, who share a common market for labor services, pay the same wage rate. Similarly, according to equation (4), in equilibrium home producers will equalize the post-tax returns from domestic and foreign investment.

Equation (5) expresses the key steady-state condition that, in long-run equilibrium, the investment required to offset depreciation and growth in the labor force must exactly equal domestic savings. We have assumed here that domestic savings constitutes a fixed percentage of total national income, *including* the returns from foreign investment.

We also have selected as our basic production relationship a CES (constant elasticity of substitution) function of the form

$$f^*(e^*) = A\,[\omega e^{*\,-\beta} + (1-\omega)]^{-1/\beta} \tag{6}$$

where β is related to ρ, the constant elasticity of substitution, by $\beta = (1/\rho) - 1$, A is an appropriate scale parameter, and ω is a weighting factor for the input of capital.

The function in (6) applies to production in the foreign sector. According to our assumptions regarding technology differences, the home and DFI sector functions can be written as

$$f_F(e_F) = \mu f^*(e_F), \tag{7}$$

$$f(e) = \lambda f_F(e), \tag{8}$$

where μ and λ measure the size of these gaps.

These eight equations are sufficient to determine equilibrium levels of the model's variables.

The dynamics of this system can be understood by referring to Figure 1, which is a modified version of the familiar phase diagram for a simple, single-sector closed economy. The function

$$G(k;t) = f(e) + (1-\tau^*)\,f'_F(e_F), \tag{9}$$

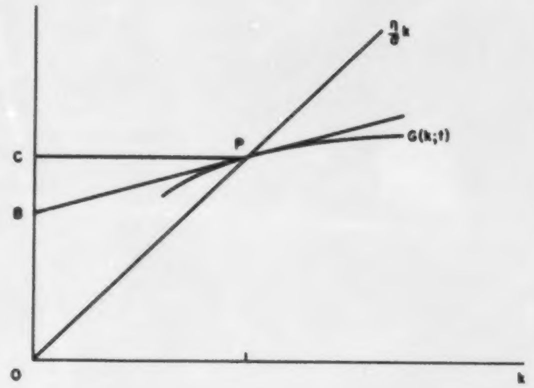

Figure 1
Phase Diagram for Determining Steady-State Values

NOTE: *PB* has slope η; *PC* is perpendicular to *OBC*; *OB* measures steady-state expenditure per capita; *BC* measures steady-state savings per capita.

where $e = e(k;t)$
$e_F = e_F(k;t)$

measures per capita national income, including the post-foreign-tax returns from foreign investment when equations (1) – (4) are satisfied. If the appropriate stability conditions are met,[1] the economy will move to the intersection of $G(k;t)$ and the ray from the origin with slope η/σ. At this point, labeled *P* in Figure 1, equation (5) will also be satisfied. The intersection (with the vertical axis) of the perpendicular and line with slope equal to η drawn from point *P* mark out the levels of per capita expenditure and per capita savings.

Literature Cited

1. Adler, Michael, and Guy V. G. Stevens. "The Trade Effects of Direct Investment." *Journal of Finance*, 29 (May 1974), 655–76.
2. Christensen, Laurits, Dale Jorgenson, and Dianne Cummings. "Productivity Growth, 1947–1973: An International Comparison." Paper presented to the Conference on the Impact of International Trade and Investment on Employment. Washington: Department of Labor, December 1976.
3. Christensen, Laurits, and Dale Jorgenson. "The Measurement of U.S. Real Capital Input, 1929–1967." *The Review of Income and Wealth*, 15 (December 1969), 293–320.
4. ———. "U.S. Real Product and Real Factor Input, 1929–1967." *The Review of Income and Wealth*, 16 (March 1970), 19–50.
5. Cook, Phillip J., and Robert H. Frank. "The Effect of Unemployment Dispersion on the Rate of Wage Inflation." *Journal of Monetary Economics*, 1 (1975), 241–49.
6. Frank, Robert H., and Richard T. Freeman. *Multinational Corporations and Domestic Employment*. Cornell University, 1976 (processed).
7. Freeman, Richard T. "The Optimal Foreign Investment Tax." Cornell University, Department of Economics Working Paper, July 1976.
8. Hawkins, Robert G. *Job Displacement and the Multinational Firm: A Methodological Review*. Occasional Paper #3. New York: Center for Multinational Studies, New York University, June 1972.
9. Horst, Thomas. "American Exports and Foreign Direct Investment." Harvard Institute of Economic Research, Discussion Paper No. 362, May 1974.
10. Lipsey, Richard G. "The Relation Between Unemployment and the Rate of Change in Money Wages in the United Kingdom, 1862–1957—A Further Analysis." *Economica*, 27 (February 1960), 1–31.
11. Lipsey, Robert E., and Merle Yahr Weiss. "The Relation of U.S. Manufacturing Abroad to U.S. Exports: A Framework for Analysis." *Proceedings of the American Statistical Association*, Business and Economic Statistics, 1969, 497–509.
12. Kindleberger, Charles. *American Business Abroad*. New Haven: Yale University Press, 1969.
13. Musgrave, Peggy B. *Direct Investment Abroad and the Multinational Corporations: Effects on the United States Economy*. Report prepared for the use of the Subcommittee on Foreign Relations, United States Senate, U.S. Government Printing Office, 1975.
14. Sato, Kazuo. *Production Functions and Aggregation*. New York: North Holland/American Elsevier, 1975.
15. Stobaugh, Robert B. and Associates. "U.S. Multinational Enterprises and the U.S. Economy: A Research Study of the Major Industries that Account for 90 Percent of U.S. Foreign Direct Investment in Manufacturing." Boston, Mass., 1972.
16. United States Bureau of Labor Statistics. "Tomorrow's Manpower Needs." Washington: U.S. Government Printing Office, 1971.
17. United States Department of Commerce. *Special Survey of U.S. Multinational Companies*. 1970.
18. United States Tariff Commission. *Implications of Multinational Firms for World Trade and Investment and for U.S. Trade and Labor*. Report to the U.S. Senate Committee on Finance, February 1973.
19. Vernon, Raymond. "International Investment and International Trade in the Product Cycle." *Quarterly Journal of Economics*, 80 (May 1966), 190–207.
20. Wan, Henry. *Economic Growth*. New York: Harcourt, Brace, Jovanovich, 1971.

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[1] In this case the stability condition is $\dot{k} \gtrsim 0$ iff $G(k;t) - (\eta k/\sigma) \gtrsim 0$ for all levels of *t* in the acceptable range, which is directly analogous to the stability conditions of the simple, closed-economy version of this model. In the range of parameter values we have selected, this condition is met.

Comment

Guy V. G. Stevens*

My comments will be on Thomas Horst's paper and, in a less comprehensive way, on the paper by Professors Frank and Freeman. They will be limited to what I think is the central issue in both of these papers, the substitution effect between exports and foreign investment.

Let me start by congratulating the Bureau of International Labor Affairs for supporting these studies. I think the bureau and the public got their money's worth. Both studies did what they should in that they introduced something new and important as far as research results are concerned.

Getting to particulars, Horst's development of the idea that the nonproduction aspects of direct investment may be of crucial importance for the size and sign of the substitution effect is an important contribution. It is an important and plausible hypothesis that direct investment in foreign facilities may actually push out the demand curve for the subsidiary's product.

As far as the Frank and Freeman paper is concerned, the contribution that impresses me the most is their imaginative use of economic theory and the available data — to make a breakthrough in the estimation of the elasticity of the foreign subsidiary's demand curve. It is well known that this is a crucial parameter for the measurement of the substitution effect. As a person who has tried to do this in the past and, I think, failed, I can say that this is a very welcome result.[1] I will try below to be more specific concerning the importance of their estimate and the implication of their work for future research.

The Horst Paper

The Horst paper starts with an excellent summary of the major considerations that affect the decision to locate abroad — the choice between exporting and direct investment. The most important and original point that Horst emphasizes in the paper is that the nonproduction aspects of direct investment, namely advertising and setting up distributional and service facilities, can add new elements to the firm's product market: they can actually shift out the demand curve for the firm's product over what it would be if the firm just exported from the United States.

If that idea can be verified and actually measured, then, as Horst has said, it puts the analysis of the impact of direct investment on U.S. employment in a completely different light. In fact, we may find that direct investment and exporting are complementary, and that employment may be increased by direct investment.

The only problem with the paper is that Horst eschews trying to *measure* this impact, and even verges on saying that to do so is impossible. I am glad to see that in his oral comments here he maintained only that it is very difficult — a position with which I agree. It is difficult now, especially, given the kind of data that we have. But we should be able to point to the data that are necessary and sufficient to measure the effect Horst hypothesizes. Then, if they are not available, one can push to have these data collected.

Concerning the empirical results Horst actually produces in the paper, I frankly don't see how the rankings that he has in his Table 1 *conclusively* show anything; I am not sure, but I think he might agree. These results seem to give one simple correlations or, at best, conditional correlations, holding one factor constant. As such they are subject to the criticism that has been leveled at past regression results where foreign investment was just entered as an independent variable. The foreign investment variable and the exporting variable may be determined by third factors that cause both to move in the same direction. Therefore, you can't conclusively say that these simple types of correlations or even regression results are a real test of hypotheses about the substitution effect.

Despite these drawbacks, it seems that just about all the statistical tests that have tried to measure the impact of foreign investment on exports have shown either no effect of direct investment on exports or some kind of complementarity between the two.[2]

These regressions have usually just added some kind of foreign investment variable to an export equation in which case there certainly is a simultaneous equation problem. But nevertheless, we do have this tantalizing evidence that foreign investment actually helps exports. Although it may be a misinterpretation of causality, I do not think it has yet been conclusively shown to be incorrect.

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*The views expressed here are solely those of the author and do not necessarily represent those of the Federal Reserve System.

[1] In [2], we were forced to assume a series of alternative values for the elasticities of the demand curves of U.S. subsidiaries and their competitors; our attempts to estimate these elasticities, using aggregate time-series data, led to inconclusive results.

[2] Adler thoroughly analyzed the aggregate data by country and area in [1]; in most cases (except for Japan) he found either no effect or complementarity. Lipsey and Weiss found complementarity in their study of the direct investment in manufacturing [8]. Finally, in earlier cross-section work, Horst found a positive effect of foreign subsidiary sales on U.S. exports (reported in [3]).

The Frank-Freeman Paper

Getting to the Frank and Freeman paper, I agree with their criticism, on theoretical grounds, of the correlation and regression results mentioned above. Given the simultaneous equation problems present, one can construct models where exports and foreign subsidiary sales are substitutes and yet, because of third factors, the regression coefficient of subsidiary sales in an export equation may be positive. However, showing the possibility of a fallacy is not proof of the fallacy. Rather, to show this latter, the researcher must demonstrate that a properly run test on the same (or very similar) data leads to the opposite result.

Concerning the many positive contributions in this and earlier papers, I should like to concentrate on their method of estimating the substitution effect between exports and foreign subsidiary sales. I commend Messrs. Frank and Freeman for their imaginative use of the marginal conditions of profit maximization and their use of revenue and cost data to get estimates of the elasticity of the demand curve for exports and foreign subsidiary sales. I think it is a novel procedure, and it led to very interesting and reasonable results. As I try to show below, their work should stimulate research in this field.

As their Table 1 shows, their results are very sensitive to the estimate of their substitution parameter σ. They have in this table a couple of alternatives to their estimated ratio. Their best guess is that U.S. direct foreign investment in 1970 led to a total loss of 160,000 jobs; but when you halve σ, the loss drops to 19,000 jobs; when you double it, it increases to 441,000 jobs. Thus their bottom line — the effect of direct investment on jobs — is very sensitive to the estimate of the substitution ratio.

Despite their innovative use of available data, policymakers should be warned — as the authors correctly do — that the estimates of σ that are presented in this paper are the first fruits of research and may not stand up to scrutiny. For one thing each estimate is based on one observation, and derived by a complicated calculation that cannot allow for errors in the data or the theory, or for the normal error term in econometric equations. Second, their procedure may have substantive flaws; concerning the possibility of these, I have two critical comments — perhaps better put as queries.

First, I fail to see in their approach one of the most important elements that I thought was wrapped up in the analysis of the substitution effect: assumptions about the behavior of competing foreign firms. Heretofore all estimates of the substitution effect have depended on assumptions or estimates of what foreign competitors would do if U.S. firms were prevented or restrained from investing abroad (see [5, 2]). In the extreme case, dubbed by Hufbauer and Adler [5] as the "reverse classical" case, we might expect foreign competitors to jump into the market that U.S. firms were restrained from serving by direct investment; in this case, exports would not be helped by restraining direct investment. It is my opinion that Frank and Freeman have not adequately accounted for this factor; in fact, it seems to me that implicit in their analysis is the assumption that foreign competitors will do *nothing* if direct investment is restrained. Since the authors disputed this conclusion at the conference, as an appendix to this comment I provide a short counterexample; this shows, I think, how their framework cannot, generally, be accounting for the effects of foreign competition. If I am correct, most would agree that something should be done to incorporate this neglected effect into their framework.

The final comment I have about their procedure is their use of σ to calculate the marginal effects for 1970, in their Table 1. I am not sure that it is a proper way to calculate a marginal effect. Their question is: "What happens to jobs if we ban the direct investment that happened in 1970?" And they use their average σ of 0.33 as an important parameter to calculate this employment effect.

Now, just as a counter-example, suppose that in 1970 the total production from direct investment abroad was well above the level that would be exported if all U.S. firms were forced to produce only at home. That would mean that even if you held *incremental* direct investment in 1970 to zero, there probably wouldn't be *any* effect on exports; for we would already have production abroad that would be above the optimal level of exports. Yet their calculation gives a different result. This is so, I think, because their substitution parameter is a *global* estimate: what would happen if you *completely* banned foreign investment and made U.S. business sell *all* its foreign facilities. It should not be used without modification to calculate the incremental effect of putting a partial ban, or some kind of partial constraint, on foreign investment activity.

Implications for Future Research

I would like to close by reiterating what I see as the implications of these two studies for future research. First, both studies indicate the need for more work on the careful estimation of the substitution effect between production abroad through foreign subsidiaries and exporting from the United States. Frank and Freeman give us hope that we can make progress in measuring the key parameters that determine the substitution effect. Horst points to a new set of considerations that must be taken into account and measured, factors dealing with how production abroad affects the foreign demand for products produced by U.S. firms.

Second, it is clear that the theories underlying these two studies are not consistent: Horst's implies that direct investment may shift out the demand curve for the product previously exported, whereas Frank and Freeman's makes the usual assumption that the foreign demand curve is unaffected by the location of production. Both papers have done a good job in describing the factors that underlie these theories and the differences in their implications. What remains to be done is to see if these conflicting theoretical strands can be integrated into a more general model — one that is linked to empirical data, existing or potentially collectable, and that, therefore, can be used to test the alternative hypotheses.

Appendix

Frank and Freeman define their σ as the ratio of (1) the optimal level of output (QH) if the firm is constrained to supply the market from exports from the United States and (2) the optimal level of output (QF) if the firm is allowed to produce outside the United States, where it is presumably cheaper. The rates of these two-level QH/QF equals σ; for their calculations they make further assumption that each added unit of production abroad will replace σ units of exports from the United States.

For both cases the optimal output level is determined as the result of a simple profit maximization problem: the following profit (π) function is maximized by the choice of an optimal Q:[3]

$$\pi = P(Q)Q - C_i(Q),$$

where Q is quantity; $P(Q)$ is the price function for the market, i.e., the reverse of the downward sloping demand curve for the foreign market; and $C_i(Q)$ is the cost function for production in location i. i can equal H (home production) or F (production abroad).

Frank and Freeman specify their demand (price) curve as Cobb-Douglas: $Q = NP^{-n}$; constant marginal costs are assumed: thus $C_i(Q) = MC_i \cdot Q + K$, where MC_i is the constant marginal cost for the particular production location and K is some (irrelevant) level of fixed costs. A very important point is that the intercept of the firm's demand curve is a constant N; in particular it is not a function of what competitors do. Under these circumstances, the authors show that their ratio σ is a function of marginal costs and the (constant) demand elasticity (n) alone.

$$\sigma = QH/QF = [MC_f/MC_H]^n.$$

The following simple example shows that this sort of procedure does not generally account for the actions of competing firms. We will consider a case with constant marginal costs identical to Frank and Freeman; to simplify things we will assume that the market price (demand) curve is linear: $P = a - bQ$, where Q is total market supply. In our example we will specify precisely the behavior pattern of competing firms: for simplicity assume that there is one other firm supplying an identical product to the foreign market; in this duopoly situation, we will assume that each competitor adopts Cornot-type behavior: maximizing his profit function on the assumption that the competitor does not react. We will show that estimates made of $\sigma = QH/QF$ on the basis of any given equilibrium position — as done by Freeman and Frank — will be incorrect. The reason is that such estimates will not account for the reaction of the competitor as the equilibrium changes.

The market price curve (inverse of the market demand curve) is $P = a - bQ$; since total output Q is produced by firm 1 and 2, $Q = Q_1 + Q_2$. The U.S. multinational maximizes profits, assuming as given the current level of the competitor's output (Q_2).

$$\max \pi = [a - b\,(Q_1 + Q_2)]\;Q_1 - MC_i\;Q_1\,.$$

As discussed above, the optimal level of home and foreign production is found by inserting, respectively, the marginal cost at home (MC_H) and abroad (MC_F).

Maximizing with respect to Q_1: the firm sets the following marginal equation to zero:

$$(a - bQ_2) - 2bQ_1 - MC_i = 0. \tag{1}$$

This leads to optimal levels of home and foreign production of

$$Q_H = \frac{(a-bQ_2) - MC_H}{2b} \tag{2}$$

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[3] This model is developed in detail in their earlier paper [6].

$$Q_F = \frac{(a-bQ_2)-MC_F}{2b} \tag{3}$$

We might estimate these levels, or their ratio σ in ways similar to those suggested by Frank and Freeman. To get

$$\sigma = \frac{QH}{QF} = \frac{(a-bQ_2)-MC_H}{(a-bQ_2)-MC_F},$$

we need measures of the marginal cost of production at home and abroad and a measure of $(a-bQ_2)$, this latter is a measure of the intercept of the firm's demand curve. Frank and Freeman needed exactly the same cost data. Analogous to Frank and Freeman we can manipulate the data *at any point of equilibrium* to get estimates of $a - bQ_2$ and any other parameters of the system. Thus:

$$\begin{aligned} P &= (a-bQ_2)-bQ_1 \text{ and} \\ a-bQ_2 &= P + bQ_1. \end{aligned} \tag{4}$$

In addition, the first-order condition (1) for a profit maximization states:

$$a - bQ_2 - bQ_1 = bQ_1 + MC\text{ ; or } P = bQ_1 + MC. \tag{5}$$

Hence from (4) and (5):

$$a - bQ_2 = P + bQ_1 = P + P - MC = 2P - MC.$$

Thus an estimate of σ constructed in a way similar to that used by Frank and Freeman (using data from any observed point of equilibrium) would be

$$\sigma = \frac{2P - MC_i - MC_H}{2P - MC_i - MC_F}.$$

Within the framework of this model, the above measure of σ is *wrong*. All the data that are used to construct σ presuppose that the production level of competitors will be Q_2 – the particular level of supply by competitors at the time the data were gathered for the calculation of σ. However, this level Q_2 will almost certainly *not* be the level of competitors' production in any *other* set of circumstances: in particular the case where all production is forced to be done at home (the case leading to Q_H), or the alternative, where all production is done abroad (Q_F). Because of the duopolistic market situation, as the multinational adjusts its supply to the foreign market, so do its competitors. The levels of Q_2 for the two polar cases behind the calculation of Q_H and Q_F will both be different, and different from any intermediate point of equilibrium. For this reason, given this model, no data can be used in the way suggested above to calculate an unbiased σ. The variations in Q_2 must be taken into account to obtain an unbiased estimate of σ.

In fact we know the estimate of σ will usually be biased *upward*. If home costs are higher, the actual level of Q_2 for the case of all production at home will be higher than the Q_2 actually observed when some production is undertaken abroad; thus the numerator of σ will be lower than estimated. Similarly the level of Q_2 corresponding to all production abroad will be greater than or equal to the observed Q_2, thus leaving the denominator unchanged or higher.

In this particular case, one might note that one can take account of the effect of foreign competitors just by knowing the marginal cost faced by these competitors (MC_C).

Profit maximization by the competitor adds one more marginal condition to the model.

$$a - bQ_1 - 2bQ_2 - MC_C = 0. \tag{6}$$

Equations (1) and (6) can be used to solve simultaneously for Q_1 *and* Q_2. It can be verified that the new, true reduced-form solution for

$$Q_1 = \frac{3a + MC_C - MC_i}{3b}. \tag{7}$$

This can be compared to (2) and (3) by substituting MC_H or MC_F for MC_i. The values for Q_H and Q_F calculated from (7) are the correct ones to use in calculating the σ sought by Freeman and Frank.

Literature Cited

1. Adler, Michael. "Direct Interactions between U.S. Exports and Sales by U.S. Direct Investment Ventures Abroad." Unpublished paper prepared under contract with U.S. Department of State, Graduate School of Business, Columbia University, November 1971.
2. Adler, Michael, and Guy V. G. Stevens. "The Trade Effects of Direct Investment." *The Journal of Finance*, (May 1974), 655–76.
3. Bergsten, C. Fred, Thomas Horst, and T. H. Moran. *American Multinationals and American Interests*. Washington: Brookings Institution, forthcoming.

4. Horst, Thomas. "The Impact of American Investments Abroad on U.S. Exports, Imports and Employment." Paper presented at the Conference on the Impact of International Trade and Investment on Employment, Bureau of International Labor Affairs, U.S. Department of Labor, Washington, D.C., December 1976.
5. Hufbauer, Gary C., and Michael Adler. *Overseas Manufacturing Investment and the Balance of Payments*. U.S. Treasury Tax Policy Research Study No. 1. Washington: Government Printing Office, 1968.
6. Frank, Robert H., and Richard T. Freeman. "Multinational Corporations and Domestic Employment." Cornell University, 1976 (processed).
7. _____. "The Distributional Consequences of Direct Foreign Investment." Paper presented at the Conference on the Impact of International Trade and Investment on Employment, Bureau of International Labor Affairs, U.S. Department of Labor, Washington, D.C., December 1976.
8. Lipsey, Robert E., and Merle Yahr Weiss. "Exports and Foreign Investment in Manufacturing Industry." National Bureau of Economic Research, Inc., Working Paper 131, May 1976.

Comment

Donald J. Rousslang*

This comment deals with the calculations Frank and Freeman made in deriving the export displacement effects of overseas investment by U.S. firms. These calculations are not presented in the summary paper prepared for this conference, but they are important to its results. The calculations are subject to criticisms that can substantially change the magnitude, and even the direction, of the short-run employment impacts reported in the conference summary.

Frank and Freeman's methodology requires estimation of the foreign demand curve for the product of a U.S. firm that has some monopoly power. This demand curve is assumed to have a constant elasticity (η). If the U.S. firm is currently supplying the foreign demand with output from subsidiaries located abroad, the elasticity of demand can be calculated from the equation

$$\eta = \frac{-P/MCF}{(P/MCF)-1}, \tag{1}$$

where P is the price charged for subsidiary output and MCF is the marginal cost of subsidiary production.

Frank and Freeman assume marginal costs are constant and replace equation (1) with

$$\eta = \frac{-R}{R-C}, \tag{2}$$

where R is the total revenue of subsidiaries and C is the total variable costs of subsidiary production. Once the demand curve is obtained, the costs of supplying the foreign demand through exports can be compared with the costs of supplying this demand through subsidiary production in order to obtain an estimate of the exports displaced by subsidiary output. A mathematical expression for α, the ratio of displaced exports to subsidiary production, is

$$\alpha = (MCF/MCH)^{-\eta}, \tag{3}$$

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*This comment is derived from a forthcoming review of studies on the employment impacts of international investment by Harry Grubert and Don Rousslang, Office of Foreign Economic Research, Bureau of International Labor Affairs. The views expressed in this comment do not necessarily reflect those of the Department of Labor.

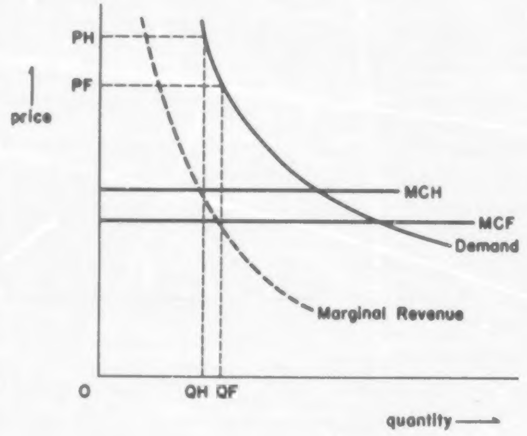

Figure 1

where *MCH* is the marginal costs of U.S. exports, including transportation and tariff costs, assumed to be constant.

A graphic example of Frank and Freeman's methodology is given in Figure 1. Here the export displacement effect is given by the ratio (*QH*/*QF*), where *QH* is the quantity the firm would export from the United States in the absence of subsidiary production and *QF* is the quantity the firm would choose to supply with subsidiary production.

From Figure 1 and from equation (3) we see that as long as *MCF* is less than *MCH*, the offset coefficient α is greater when demand is less elastic. From equation (2) we see that the smaller the cost figure used, the smaller is the estimated elasticity of demand. There are two important reasons why the cost figures used by Frank and Freeman may result in underestimating the elasticity of demand. (1) They assume that marginal costs are constant and therefore equal to average variable costs. This probably understates true marginal costs. (2) Frank and Freeman used accounting costs to calculate η from equation (2), a procedure that does not account for the opportunity cost of capital.

Since overseas investment has been growing, it is unlikely that subsidiaries have been operating under conditions of constant short-run marginal costs, and it is also unlikely that they have been operating at output levels less than those necessary to achieve minimum average total costs. Therefore it is unlikely that short-run marginal costs have been less than average total costs, and it would probably be a better procedure to use average total cost in place of short-run variable cost in equation (2). This will increase the estimated elasticity of demand, since average total cost always exceeds average variable cost. The estimated demand elasticity is further increased if the average total cost is made to include the opportunity cost of capital.

The following example shows why exclusion of opportunity costs is inappropriate. Suppose a firm operates under conditions of perfect competition and faces a perfectly elastic demand curve. Even if the system is in long-run equilibrium, accounting costs need not equal total revenues so long as there is an opportunity cost of capital. But if accounting costs were used in equation (2), the estimated elasticity of demand would be less than infinite.

Using total cost instead of total variable cost in equation (2) and including a 10 percent rate of return to capital as its opportunity cost greatly increases the estimated demand elasticities. This reduces the estimated export displacement effects to such an extent that they are more than offset by the export stimulus effects that result from subsidiary imports of parts and equipment from the United States.[1]

The arbitrary nature of Frank and Freeman's estimates of the short-run employment impacts of overseas investment has been demonstrated above by showing the variability of these estimates with respect to reasonable changes in the assumptions. Other assumptions used by Frank and Freeman are also subject to question. For example, in another recent attempt to estimate the effect of direct foreign investment on U.S. exports, Adler and Stevens [1] used the assumption that subsidiary output was a perfect substitute for output of native firms in the host country but not for U.S. exports. Frank and Freeman's methodology is inappropriate where this assumption holds. They use the assumption that subsidiary output is a perfect substitute for U.S. exports, but not for output of native firms. Another possibility is that other foreign producers may be induced to enter the market at price levels between *PF* and *PH* in Figure 1. In this case, the demand curve may become much more elastic in the range between these prices, which would reduce the export displacement effect from that calculated by Frank and Freeman.

Literature Cited

1. Adler, Michael, and Guy Stevens. "Direct Investment and Trade: An Analysis of the Export Displacement Effect." *Journal of Finance* (May 1974), 655–76.

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[1] These calculations are available in a forthcoming review of investment studies by Harry Grubert and Don Rousslang.

Technology Transfer: Effects on U.S. Competitiveness and Employment

Jack Baranson*

1. Project Overview

Project Focus

For some time now, it has been the prevailing view that U.S. industry has a self-interest in restricting the release of proprietary technology and that this attitude has safeguarded U.S. economic interests. Conventional wisdom has argued that, on balance, U.S.-based multinational firms have minimized losses in U.S. income, trade, and employment through judicious investment and licensing in foreign facilities, without which residual earnings for the U.S. economy would have been greatly diminished or entirely lost. It is further argued that manufacturing investments made to serve local markets that are otherwise closed to imports also generate exports of components and equipment for overseas production, which would otherwise go to foreign suppliers. This viewpoint is reinforced by corollary assumptions that (a) American firms enjoy substantial commercial leads in high technology fields, (b) they will continue to invest in R&D to maintain these leads as major sources of design and manufacturing technology, and (c) there is little danger of competitive threats from enterprises in newly industrializing nations (including the socialist economies and resource-rich developing countries) in the foreseeable future.

More recently, concern has been expressed over the dissemination of U.S. technology to other economies and the adverse consequences these transfers may have for our economy. Some analysts have begun to argue that U.S. firms are contributing to both the deterioration of U.S. trade balance and to the loss of technical leadership by establishing foreign manufacturing affiliates and by licensing their technology to foreign manufacturers (see [2, 4]).

A new generation of technology transfer arrangements with noncontrolled foreign enterprises has given further cause for concern. The following scenarios illustrate these new arrangements:

> General Motors Corporation is negotiating a new agreement with a Polish state-owned automotive manufacturing enterprise (POLMOT) that represents a landmark of change in U.S. business involvement in overseas markets. Under the proposal, General Motors will design and engineer for volume production (100,000 units/year) in Poland a new line of vehicles ranging from light pick-up vans to medium trucks in the 5-metric-ton range. General Motors will market under its trade name a percentage of the Polish plant's output — 15,000 units is the likely number, initially. GM will train Polish managers and technicians in their facilities located in England and other parts of Europe, and Polish technicians will participate in the design and engineering of the new truck line. The proposed GM agreement takes a significant step beyond the coproduction and comarketing agreements that have been negotiated by American and other foreign enterprises in Eastern Europe in that it includes the sharing of design and engineering of a new product line for the highly sophisticated and competitive Western European market.
>
> Cummins Engine Company, a billion dollar corporation, is committed to sharing the production function on its newest generation of diesel engine design with its licensing affiliate in Japan, Komatsu, a leading tractor and construction equipment manufacturer. Based upon a comparative analysis of capital requirements for future expansion of R&D, marketing, and production capacities, the latter was found to be least efficient in terms of relative rates of return. Cummins' long-range planning seems to point toward a shifting center of gravity in the direction of a technology and marketing company, rather than a manufacturing company.
>
> In March of 1975, a leading U.S. auto parts manufacturer completed four years of negotiations with a socialist country for a sizeable contract under which the firm will supply manufacturing equipment and technical know-how for an auto parts manufacturing plant. The technology and equipment — including metallurgical, mechanical, electroplating, and casting lines — will be the most sophisticated available and promises to produce an internationally competitive product. The contract was the first one this firm had negotiated with the particular country, and its officials quickly realized that they faced an astute and well-informed bargaining agent. They felt a lack in both the backstop commercial and economic intelligence and an understanding of their

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*The views expressed in this paper are those of the author. They do not necessarily reflect those of the U.S. Department of Labor. The paper is based on Jack Baranson's "International Transfers of Industrial Technology by U.S. Firms and Their Implications for the U.S. Economy" under contract ILAB 75-17.

adversary's behavior in negotiating for and acquiring foreign industrial technology. A major asset that the U.S. firm had was a "cadillac-line" technology, which their client seemed to prefer, and this is what ultimately led to an agreement on their terms.

Between 1972 and 1975, Fujitsu Ltd., a leading computer manufacturer in Japan, acquired progressive access to highly advanced computer technology developed by the Amdahl Corporation, founded in 1970 by a former IBM design engineer. Amdahl equipment enables users of IBM equipment to double the cost effectiveness of their data processing. In return for successive rounds of venture capital, Fujitsu, backed by Japanese government financing, acquired full patent and manufacturing rights for Japan and has since moved the technology to Spain and is negotiating with Siemens in Germany for sharing Amdahl technology. Eighty percent of Amdahl computer manufacturing requirements have been shifted to Fujitsu in Japan. Fujitsu is now planning to use Amdahl component technology to design and manufacture small to medium computers for sale in the U.S. market.

In 1971, General Electric entered into a joint venture with SNECMA, the French government-controlled manufacturer of military aircraft engines, to design and manufacture 10-to-15-ton civilian prototypes. Under the agreement, GE was to provide technology for the "hot-core" (compressor portion) of the jet engine, originally developed for the U.S. long-range B-1 bomber. R&D expense (estimated at nearly a half billion dollars — twice GE's annual R&D budget) and ownership of the new engine was to be shared by GE and SNECMA. GE entered into the agreement to maintain its long-term position in the civilian aircraft engine market globally. The agreement represented a marked shift in GE's willingness to share front-end technology with another commercial group.

General Telephone and Electronics in 1972 signed a $223 million contract with SONELEC/Algeria to build a completely integrated consumer electronics plant, from raw materials through component manufacture (including cathode-ray tubes and semiconductors) to end products (TVs, radios, tape recorders, and cassettes). Under the agreement, over three hundred Algerian technicians and managers, ranging from shop foreman to plant director, are to be trained in the United States at a cost of $25 million. SONELEC is planning to manage the facility entirely with Algerian nationals within two years.

In 1975, Honeywell entered into a joint venture with CII, the dominant French computer firm, strongly backed by the French government ($280 million in R&D funding and over $400 million in government purchases). The strong inflow of U.S. technology was a condition of Honeywell's entry into the French public sector market.

The foregoing scenarios are excerpts from twenty-five case studies Developing World Industry & Technology prepared in five industries — aircraft, automotive, computers, consumer electronics and chemical engineering. (See Table 1 for complete listing of case studies.) The scenarios cited represent the forefront of a trend revealed in the case material in which U.S. corporations have redefined their "self-interest" such that under some circumstances, they now find attractive the sale of industrial technology to noncontrolled foreign enterprises. The technology sold, in such cases, is in-

Table 1
Industries and Case Studies

Aircraft	Automotive	Computers	Consumer Electronics	Chemical Engineering
General Electric—SNECMA (France)	General Motors—POLMOT (Poland)	Amdahl—Fijutsu (Japan)	General Telephone & Electronics—SONELEC (Algeria)	UOP—Foreign Auto Firms
General Dynamics—European Consortium	Cummins Engine—Komatsu (Japan)	Honeywell—CII-HB (France)	Sigma Instruments*—Nippon Electric Instruments (Japan)	Sohio—PRC
Sikorsky Helicopters—VFW Fokker (West Germany)	Gamma Auto*—Socialist Country	Control Data—ROM-SRL (Roumania)	Motorola—Matsushita (Japan)	Fluor—Saudi Arabia & Iran
Lockheed—Kawasaki (Japan)	Swindell-Dressler—U.S.S.R.	Singer—ICL (U.K.)	RCA/Corning—UNITRA (Poland)	Alpha*—Worldwide Transfer
Piper Aircraft—EMBRAER (Brazil)	Bendix—Bosch (West (Germany)	Dataproducts—Videoton (Hungary) and Tokyo-Juki (Japan)	Fairchild Camera—Kyoto Ceramics (Japan)	Beta*—Developing Countries

*The U.S. firms marked with an asterisk were assigned pseudonyms, due to the sensitive nature of the information provided by their officials.

creasingly the most sophisticated and recent generation available, and its release is often under terms that assure a rapid and efficient implantation of an internationally competitive productive capability. This trend represents a radical departure from the traditional transfer modes of direct foreign investment and licensing, in which the technology released was generally based on "mature" product lines and generally available production techniques.

A basic thrust of our research effort has been to explore often conflicting viewpoints and to develop some new insights and understanding on the economic impact of certain technology transfers. A central objective was to identify the determining factors and conditions that influenced the U.S. corporation's decision to enter into the agreement, including the extent and timing of the transfer. We have attempted to trace through, where feasible, the effects of such transfers on the productive capabilities of recipient enterprises, and the consequences for the U.S. competitive position in world markets (and their implicit impact upon levels and distributions of U.S. employment and national income).

The study also aims at shedding more light on what is meant by the term "technology transfer" and which modes of transfer (and related conditions and practices) lead to the most rapid, premature, or otherwise disadvantageous erosion of the firm's proprietary technology. A purposeful effort has been made to isolate technological factors from other operating considerations, and to distinguish between relatively innocuous transfers of standardized technology easily available from alternative sources and the more advanced or sophisticated technology that cannot readily be obtained from other U.S. companies or elsewhere in the world. Important distinctions are drawn between the sale of turnkey plants or process elements and the implanting abroad in the foreign enterprise of technical know-how to duplicate the technology or to design and engineer new generations of technology from the base acquired under the licensing arrangement.

Technology, as used in this study, refers to the package of product designs, production and processing techniques, and managerial systems that are used to manufacture particular industrial products. A modern truck diesel engine consists of approximately 750 individual parts and requires over 30,000 separate steps to convert industrial materials (over 350 different kinds) into finished components. The technology package consists of detailed process sheets, materials specifications, processing and testing equipment designations, and quality control procedures. Together they are a measure of "quantum and complexity" of a technology transplant.[1] These tens of thousands of elements for a single industrial product, such as a high-speed diesel, are meticulously accumulated over time through research and development, and through trial and error in equipment, factory methods, and the detailed specifications and procedures developed through prolonged experience. This is even more true of the chemical processing and other high-technology fields such as computers and jet aircraft. Technology transfer is best effected through sustained enterprise-to-enterprise relationships, during which time, elements of the technology package are conveyed to the recipient through the provision of the aforementioned technical data, training and demonstration, and through an interactive process of adjusting implanted procedures and equipment operation until the desired end products, including production efficiencies and quality standards, are achieved.

The continuum of technology packages may range from mere patent and trademark rights to a complete "turnkey-plus" plant that includes all of the foregoing. Management service contracts stand in the forefront of highly effective technology transfer modes to implant operative technology — including the training of managers and technical supervisors — in a rapid and efficient way.

An important set of distinctions needs to be drawn among "firm specific," "system-specific," and "general" technology.[2] The first refers to the tried-and-tested, practical knowledge that a firm has developed over time to produce a particular product — with all the bits and pieces fitting together and functioning at a cost-competitive level. "System-specific" refers to specialized capabilities that a firm may have developed over time in such areas as welding techniques (for example, to attach the fins of a turbo-jet engine to the drive shaft) or casting techniques for a special alloy (of high quality without porosity for the same turbo-jet engine). "General" knowledge is the easily obtained, nondetailed, information about design and manufacturing principles for, say, fractional horsepower electrical motors.

Another critical aspect lies in the distinction between implanting "operational" (turnkey) technology and imparting technical capabilities to duplicate that technology which, in some cases, may lead to an indigenous capability to design and engineer industrial systems. The Japanese have been particularly successful in using licensing arrangements as stepping stones to self-sufficient technological capabilities, which were eventually used to develop new generations of internationally competitive products, processes, and production systems. Achieving worthwhile results in the latter area depends in part upon the stage of development of the recipient enterprise and supporting industrial sectors.

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[1] For further details on measuring and quantifying this "quantum and complexity," see [1, pp. 18–23].

[2] This is a basic distinction drawn in [5].

Research Approach

Selection of the twenty-five case studies was based on several criteria. First, each case study must have identified a particular agreement between a U.S. firm and a noncontrolled foreign enterprise, resulting in the transfer of proprietary, industrial technology to the foreign enterprise. Secondly, our analytical model called for a diversity of corporate considerations, purchaser environments and technology packages. We attempted to select cases that, collectively, would provide a representative sample of this universe. Our search for suitable case materials was also based on the experience and knowledge of DEWIT associates and consultations with other individuals in government and industry who are knowledgeable in the sectors researched. In some instances, we were able to capitalize on a unique access to company information enjoyed by a case writer. Access to and availability of information on a particular agreement were not unimportant considerations in case study selection. Of approximately fifty possibilities for case write-ups, 35 percent were discarded for lack of information and an additional 15 percent rejected on the ground that they contained a theme similar to one already selected.

The subject of international licensing and the transfer of technology is, in most technology-based companies, highly proprietary. Although general policies and hypothetical scenarios are acceptable topics of discussion, most firms are loathe to disclose details of industrial licensing arrangements. This is true for a variety of reasons. First, there is a pervasive feeling within the U.S. business community that recent attention focused by various governmental agencies and congressional committees on their overseas activities has been excessive and that the new disclosure requirements reduce their flexibility in overseas operations. Secondly, several of the cases of technology transfer selected for study have been highly controversial and have generated considerable discussion in government and labor circles and the press on corporate responsibility beyond their immediate responsibility to earn returns for the shareholder. Thirdly, in some of the cases, the U.S. firm had entered into an agreement with the purchasing enterprise that prohibited the release of any information related to the transfer agreement, with the exception of information required by their respective governments. And, finally, technology transfer that takes the form of joint ventures or acquisition can be construed, at times, as having trade restricting overtones and U.S. firms, anxious to avoid any suggestion of antitrust violation, will be reluctant to discuss a particular transfer.

The experiences of the case writers varied widely in their efforts to obtain from corporate officials information that related to the scenario in question. Some investigators encountered corporate officials who were extremely cooperative and sensitive to the issues and questions we raised in interviews. In a few instances, the official articulated a concern that his corporate interest in selling a particular technology to a noncontrolled foreign enterprise may not be in the best interest of the U.S. economy. Some officials even indicated a concern for the competitive position of their own firm over the long term as a result of the sale. Four of the firms interviewed were granted anonymity in the case write-ups in exchange for their providing sensitive material on a particular technology transfer agreement. In those cases, a pseudonym is used instead of the real name of the firm in the case study. In those cases where relevant information was denied by the U.S. party to the agreement, the case writer had to rely on information obtained from trade journals, officials in trade associations, U.S. government officials with knowledge of the agreement, and academicians. Most of the case studies are based on a combination of interviews with corporate executives and informed noncorporate individuals, and readings in diverse publications ranging from congressional testimony and trade association literature to annual reports and business magazines and newspapers. In developing scenarios, the case writer was on occasion confronted with the "Rashamon" phenomenon, with different sources of information on the same set of events each telling a different story. Where discrepancies did appear among the various sources of information, it was left to the case writer's discretion and judgement to resolve or explain the differences in viewpoint.

A draft copy of each case study was sent to the relevant corporate official (generally the vice president for international operations or international licensing and patents) with the request that it be reviewed for factual or interpretive inaccuracies. We also solicited from the officials any additional material or information they felt bore on the case. Significant differences in viewpoint or interpretation are noted accordingly.

The Analytical Model

Our analytical model has been designed to draw from the case materials policy implications as they relate to impact on the U.S. economy. The technology transfers depend upon an interrelated set of factors consisting of (a) the motivations, strategies and capabilities of technology suppliers (conditioned, in part, by government policies and economic situations); (b) the astuteness, bargaining power and absorptive capabilities of recipient enterprises (as reinforced or conditioned by government action and economic policies); and (c) the nature, quantum, and complexity of the technology transferred. Each of these elements is described in what follows.

A summary view of the analytical model appears in Table 2. What is actually transferred and the timing of these transfers is a function of the supplier enterprise strategies, supplier government policies, purchaser enterprise objectives, and bargaining position as reinforced or conditioned by purchaser government policies and activities.

It was not feasible, nor within the scope of this study, to trace through the net effect of technology released in individual cases. The case material does, however, provide insights into the problem and indicate how quantitative research in this area might be pursued. The employment consequences of exporting American technology have multiple effects, as follows:

- An increase in U.S. technical employment in research, design, and engineering services (unless work is done by the U.S. firm's foreign subsidiary).
- An increase in employment in the capital goods industry supplying equipment associated with the transferred technology.
- A decrease in employment for American competitors of foreign firms who have acquired advanced technology and are able to displace U.S. firms' market shares.
- A stimulus of foreign competition that could force U.S. firms to upgrade production facilities and thereby create new jobs in capital goods and maintain or expand production jobs.
- An increase in employment, to the degree that technology exports to foreign economies raise per capita income (particularly in developing countries) and generate increased demand for U.S. exports.

Table 2
Analytical Model: Technology Transfers by U.S. Corporations

Supplier Enterprise, Government	Technology	Purchaser Enterprise, Government
Government policies	Quantum and complexity	Government policies
Economic	License to manufacture or turnkey-plus	Economic
Political	Operative-duplicative-innovative	Political
Strategic	General-firm-system specific	Strategic
Bargaining power	Stage in product/process cycle	Bargaining power
Government controls over enterprise action		Absorptive capabilities
Technological lead of enterprise		Alternative sources of technology
		Astuteness
		Financial resources
Enterprise strategies		Enterprise strategies
Shift from equity investment and management control to sale of technology and management services		Internationally competitive technology
Measured release of core technology		Duplicative and/or innovative design engineering capabilities
Release of technology no longer central to company business		Market entry to export exports
Necessity to accept foreign affiliate due to enormity of R&D or capital investment costs, offset requirements, scale of operation requires consortium		Training of technical managerial manpower
		Fast, efficient technology transplants

Source: Developing World Industry and Technology, Inc.

The net effect of the above depends upon the relative levels of job-eroding versus job-generating effects, and the response of U.S. industry to meeting new technological challenges in the form of foreign competition. It is also clear that different occupations in the U.S. labor force will be affected by different impacts — increased technical and related high-skill employment in technology exporting firms and decline of blue-collar production jobs among U.S. firms competing with foreign production facilities based upon newly acquired technology.

2. Summary of Findings

The following is a summary of case material findings according to the analytical model categories: corporate strategies, technology purchasers, and the technology package.

Corporate Strategies

The willingness to release proprietary technology to noncontrolled enterprises has stemmed from a variety of motivations and conditions. The motivations range from acute capital shortages (as in the Amdahl-Fujitsu case) to the sale of technology that is no longer central to company business. The shift from equity position and managerial control of overseas production facilities to management service contracts (GM-POLMOT and GTE-SONELEC) is in part due to the shift in the nature of demands for industrial technology by purchasers (particularly in Eastern European countries) and in the relative bargaining position of resource-rich developing countries. The shifts are also due to a major change in corporate attitudes towards overseas capital investments in plant and equipment.[3] The new trend has contributed to an acceleration of implanted capability to noncontrolled foreign enterprises, which may then pose formidable competition in world markets (as in the General Motors-POLMOT and Amdahl-Fujitsu cases).[4]

In cases involving the "measured release of core technology," much depends upon the astuteness and bargaining positions of the foreign purchaser relative to the U.S. firm. The ability of the U.S. firm to maintain its technological lead, and to continue to commercialize that lead effectively in world markets from both the corporate and the U.S. economy's viewpoint, are two other determinant factors. The sale of technology that is not central to a company's business may have important backlash effects on other U.S. firms in domestic and foreign markets. A technically strong and commercially aggressive foreign purchaser may preempt third-country markets, or second-generation R&D by the foreign enterprise group(s) may result in a new aggressive outward thrust, e.g., Japanese color television, pocket computers, and solid-state tape recorders. U.S. firms are particularly vulnerable where they face the necessity to accept a foreign affiliate due to the enormity of R&D outlay [illegible] duction tooling requirement (GE-SNECMA and Amdahl-Fujitsu). Nontariff barriers to entry or offset purchase requirements — typical of the aircraft industry — are two other conditions that undermine the U.S. firm's bargaining position, particularly where the foreign enterprise is strongly supported by government policies and financial resources (aircraft in France and Germany and computers in Japan and France).

The nature of what a particular firm is willing to release and the timing of the technology release depend in part on whether the firm considers itself essentially a production and marketing group, as distinct from a process design or construction engineering firm. This distinction is especially evident in the chemical industries. For example, a conglomerate enterprise such as UOP is really three firms in one. The product firm that markets automobile catalytic converters is particularly wary of releasing production technology to potential competitors that can "run" with the acquired technical know-how. Their process design company is interested in selling newly developed technology as extensively as it can, and reinvesting a portion of its profits in developing new generations of technology. There is little concern for the competitive potential of technology purchasers. The construction engineering group expertise lies in systems management and the logistics of fast and efficient installation and run-in of turnkey plants. The process technologies embodied in installed equipment are black box elements of an overall plant construction project, and as such are of no proprietary concern.

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[3] A growing number of U.S. firms have now decided that the risks associated with capital investments in overseas plants have become too high for realized rates of return. For General Motors in 1975 foreign operations represented 28 percent of total sales but only 15 percent of earnings, virtually all of which came from Canada. Aside from the political uncertainties in a widening area of the world, there are the economic vicissitudes brought on by world inflation, exchange-rate revaluations and recessionary cycles, all of which have added to the risks of locking into fixed investments in a world of changing circumstances. These uncertainties have been compounded by the fragmentation of world markets resulting from import substitution behind tariff barriers and regional trading blocs as a partial offset to the inefficiencies of protected national economies. Additional financial burdens have resulted from expanded research and development costs in response to emerging demands for fuel economy, emission controls, and more stringent safety standards, coupled with more exacting demands for model changes and variations under intensified competition on a worldwide basis.

[4] The new management service contracts also represent a considerable drain of technical-managerial manpower to offshore sites. The Business Council on International Understanding is discussing contracts with fourteen U.S. multinational firms to provide orientation courses for approximately 7,200 technicians who are to be placed abroad in connection with management service contracts for twenty-three projects in nine countries.

A categorical listing of cases according to corporate strategies for release of technology appears in Table 3. The end column lists possible implications for other U.S. firms or the U.S. economy.

Technology Purchasers

This recent phenomenon, however, cannot be fully explained by examining alone the factors and conditions that motivate U.S. corporations; equally important, if not more important, is the shift in the nature of foreign demands for technology and in the bargaining power of the purchasers.

At the enterprise level, a basic purpose in purchasing technology (ranging from patent rights to turnkey plants) is to gain time and ultimately to save resources. Newly acquired technology may be used to modernize or otherwise upgrade existing plant and industrial facilities or to move into new or improved product lines and to acquire new or improved production or materials processing techniques. From the governmental perspective, industrial development goals may range from the narrowly economic (to improve productivity or to enhance competitiveness in world markets) to broader developmental and political goals (to develop decreased dependence or absolute self-reliance in "basic" or defense-oriented industries). In both instances, there are important distinctions between turnkey (operational) technology and in-depth training and technical information that would permit a technology purchaser to duplicate acquired technology and to innovate beyond that point.

From an analytical viewpoint it is useful to distinguish among three distinct recipient environments: industrially advanced economies (Japan and Western Europe); socialist countries (the Soviet Union, the People's Republic of China, and Eastern Europe), and oil-rich developing countries (Algeria and Venezuela) and/or those with a relatively advanced industrial base (Brazil and Iran). There are substantial differences among and within these groupings in terms of (a) government policies; (b) bargaining power (in terms of financial resources, astuteness in orchestrating contract negotiations, and access to alternative technology sources); and (c) technical absorptive capabilities at the enterprise level and among supporting industrial sectors. (See Table 4.)

It is official policy in several Western European governments and the Japanese government that national enterprises should acquire advanced technologies, particularly in the fields of computers, jet aircraft, and certain automotive and electronic components, in order to develop internationally competitive industries. An increasingly popular mode of transfer in these cases is formation of a joint venture between the U.S. firm and the foreign firm or consortium of firms in which the former provides the technology and the latter, with government financing, provides venture capital and R&D and production-tooling funds or the means by which nontariff barriers to market entry are circumvented or offset requirements met. To the U.S. firm suffering severe capital constraints and finding itself excluded from important markets, these can be extremely attractive terms on which to negotiate a joint venture. Amdahl-Fujitsu in the computer field and GE-SNECMA in jet aircraft are two cases in point. The firms in this grouping have demonstrated on numerous occasions a high absorptive capacity and the ability not only to duplicate and innovate U.S. industrial technology, but to commercialize and market the improved technology successfully.

The technology transfer agreements with the socialist countries have been state-negotiated and are aimed at technological self-sufficiency. This grouping, Poland and Romania in particular, have spearheaded the drive to negotiate the new generation of technology transfer agreements, which involve the implanting of internationally competitive technology and production systems (high-volume, cost efficient, and quality controlled products). This was the case in the General Motors-POLMOT case and in several other transactions with Eastern European economies involving Control Data (computer peripherals), Clark Equipment Co. (heavy equipment axles), and International Harvester (specially designed heavy-duty trailers and chassis). These agreements generally include: (a) fast and efficient enterprise-to-enterprise implantation of production capabilities; (b) patent and trademark rights; (c) marketing of end-products outside socialist country markets to earn the foreign exchange needed to pay for the acquired technology; and (d) sometimes (as in the General Motors-POLMOT case), the design and engineering of a new or improved product line to compete in world markets. Some U.S. firms have argued, speciously or naively, that this type of involvement obviates the purchaser's need to develop his own production system designs and thereby locks associated enterprises into a continuing technological dependence.

The bargaining position of Eastern European and other socialist countries is considerably enhanced by the fact that in most cases they are dealing in technologies for which there are usually several alternative sources of similar, if not as attractive, technology. In the General Motors case, if GM had turned down the

Table 3
Summary of Cases: Corporate Strategies

Scenarios	Chemical Engineering	Consumer Electronics	Computers	Aerospace	Automotive	Implications for U.S. Firms/Economy
Necessity to accept coproduction or management services arrangement for market entry.		GTE- -SONELEC (Algeria) RCA/Corning—UNITRA (Poland)		GE—SNECMA (France)	GM—POLMOT (Poland) Swindell-Dressler—USSR Gamma—Socialist country	Danger of a partner spinning off and competing against the technology supplier? Erosion of U.S. technological advantage? Failure of U.S. firms to develop more appropriate technologies to meet U.S. high wage conditions? Brain drain?
Measured release of core technology.	Alpha Beta Fluor	Sigma—Nippon Electric (Japan)	Dataproducts—Videoton (Hungary) Tokyo-Juki (Japan)	Sikorsky—VFW Fokker (West Germany)		Astuteness in managing lagged dependence? Resources and capability to maintain technological lead? Should certain firms specialize in technology transfer?
Sale of technology that is not central to company business.	UOP—Japanese auto. firms Sohio—PRC	Fairchild—Kyoto (Japan) Motorola—Matsushita (Japan)	Control Data—ROM-SRL (Roumania) Singer—ICL (United Kingdom)	Lockheed—Nippon (Japan)	Bendix—Bosch (West Germany)	Side effects on other U.S. firms in both domestic and foreign markets? Strong affiliate moves to third countries and preempts markets there—or pushes technology forward and preempts markets? Are second stage effects of R&D activities detrimental when the foreign firm takes the technology abroad? Does the position of the foreign firm lead to rapid international commercialization of the acquired technology?
Necessity to accept foreign affiliate due to: capital shortage, enormity of R&D outlay or production tooling requirement, nontariff barrier to market entry, or offset requirements.			Amdahl—Fujitsu (Japan) Honeywell—CII-HB (France)	General Dynamics—European Consortium Piper—EMBRAER (Brazil)	Cummins—Komatsu (Japan)	Defense considerations overshadow economic consequences? Particular vulnerability where there is strong foreign government backing of R&D (Japan/France)?

Source: Developing World Industry and Technology, Inc., 1976.

Table 4
Case Summaries: Purchaser Environments

Recipient Group	Chemical Engineering	Consumer Electronics	Computers	Aircraft	Automotive	Environment
Industrially advanced nations	UOP—Japanese auto firms Alpha—Worldwide	Sigma—Nippon Electric (Japan) Motorola—Matsushita (Japan) Fairchild Camera—Kyoto Ceramics (Japan)	Amdahl—Fujitsu (Japan) Honeywell—CII-HB (France) Singer—ICL (United Kingdom) Dataproducts—Tokyo-Juki (Japan)	GE—SNECMA (France) General Dynamics—European Consortium Sikorsky—VFW Fokker (West Germany) Lockheed—Kawasaki (Japan)	Cummins—Komatsu (Japan) Bendix—Bosh (West Germany)	Highest absorptive capability Public and private financing Articulated national policies for key sectors Bargaining power: generally high
Eastern Europe, USSR, and the PRC	Sohio—PRC	RCA/Corning—UNITRA (Poland)	Control Data—ROM-SRL (Roumania) Dataproducts—Videoton (Hungary)		GM—POLMOT (Poland) Gamma—Socialist country Swindell-Dressler—USSR	Medium level absorptive capability Coproduction and barter agreements State-controlled transfer aimed at technological self-development Bargaining power: state monopoly purchaser
Resource-rich developing countries	Fluor—Iran Beta—Chile	GTE—SONELEC (Algeria)		Piper—EMBRAER (Brazil)		Low absorptive capability Substantial financial resources Policy of rapid industrialization based on foreign technology Bargaining power: ready cash

Source: Developing World Industry and Technology, Inc.

deal, Mercedes-Benz (Germany) or Volvo (Sweden) undoubtedly would have been equally competent and willing to consummate a similar arrangement. Another strong bargaining factor is that the socialist governments are prepared to provide investment capital and pay for design and engineering costs, thus obviating the need for capital expenditures by the U.S. firm, which can still earn highly attractive returns on their management and technology assets.

The third grouping of purchasers — the resource-rich developing countries — is characterized by articulated government policies of rapid industrialization based on foreign technology and rapid growth of industrial facilities to process and fabricate their raw materials for world markets. The Fluor Corporation, a leading U.S. chemical engineering company, has $4 billion in new contracts in Saudi Arabia alone. In other oil-rich countries, the demands are for progressive management and control of lead sector industrial facilities. In Algeria, the agreement between SONELEC and General Telephone and Electronics is a case in point. Implicit in the agreement are motivations on the part of the Algerians to lay the base for an internationally competitive industry and an expanding self-reliance to design and engineer future generations of production systems adapted to Algeria's emerging needs and industrial capabilities. Two other considerations in contract relations involving the design and construction of industrial facilities are: (a) the training of technicians and engineers to duplicate and innovate, and (b) the progressive involvement and development of domestic capital goods industries and related supplier plants as contributions to overall industrial growth and development. The resource-rich developing countries, although they are low in technological absorptive capabilities, do have the financial resources to purchase in comprehensive packages the best technology available.

See Tables 5A and 5B through 9A and 9B for a synopsis of each of the twenty-five case studies.

Industry Trends

Policies governing the transfer of technology to noncontrolled foreign enterprises vary widely among the five industries of this study. Corporate decision-makers in their respective industries are motivated by a different set of considerations and confronted with a different set of purchasing environments. From these different sets of corporate considerations and purchasers within each industry have emerged different technology packages and modes of transfer and the timing of release of unique and proprietary technology. See Table 10 for a synopsis of the industry characteristics and trends.

U.S. firms in the aircraft industry have been faced in recent years with prohibitively high R&D costs for design of new generation technology. The development of a new airframe or jet engine is perhaps one of the most expensive undertakings in modern industrial activity. In addition, even if the U.S. firm were capable of independently financing the R&D, it finds its access to markets in the industrially advanced countries slowly but surely narrowing through the erection of nontariff barriers. Purchasers of advanced U.S. aircraft technology can be characterized by an eagerness to develop their industries to internationally competitive levels, high absorptive capabilities, and a position of strong financial government backing and financial support.

Joint ventures and coproduction arrangements between foreign firms and U.S. firms in the aircraft industry meet the needs and aspirations of both parties. The foreign firm provides the U.S. firm with funds to alleviate the financial burden of R&D and production tooling as well as the means to circumvent nontariff barriers (as the foreign status of the U.S. firm is removed by virtue of the joint venture in the targeted market). The U.S. firm provides the foreign partner with advanced technology and management systems that are the indispensable ingredients for competing in international markets. The likelihood that U.S. aircraft firms will in the near future enter into overseas turnkey arrangements, as have firms in other industries we've studied, is slim. Advanced aircraft know-how does not lend itself as well to packaging as does, say, color TV tube technology. But, more important, it appears that U.S. firms in the industry still perceive themselves as production firms and feel that their comparative advantage lies in production, whether independently or in partnership with a foreign firm.

Coproduction in the industry will be the trend for the future. In the short term, such agreements will be highly advantageous for the U.S. firms, as they will benefit from the earnings needed to develop new generations of technology and will provide access to markets from which they might otherwise be excluded. In addition, the U.S. aircraft industry can expect to gain technological improvements from its foreign partners. But, over the long term, the likely narrowing of the technology gap between the U.S. industry and foreign enterprises can lead to a buildup of potential competition in world markets.

Firms in the U.S. computer industry suffer under constraints similar to those present in the aircraft industry: shortage of capital for expensive R&D and protected foreign markets. In addition, all firms in the industry, both U.S. and foreign, must contend with the giant corporation IBM. Due to its competitive strength, some U.S. computer manufacturers have chosen to

Table 5A
Aircraft Industry

Case Study	Nature of Agreement	Sophistication of Technology	Alternative Sources of Competitive Tech.		Total Remuneration to U.S. Firm	Projected Impact on Other U.S. Producers
			U.S.	Foreign		
General Electric—SNECMA (France)	Joint venture to manufacture jet engines for civilian aircraft	Advance design, internationally competitive	Yes	Possible European consortium to develop "ten-ton" engine	Unknown	Pre-empt sales in European and other world markets
General Dynamics—European Consortium	Coproduction military aircraft	Advance design and sophisticated manufacturing know-how	Yes	Yes	Unknown	Displaces sales from U.S. production sources
Sikorsky Helicopters—VFW Fokker (West Germany)	Coproduction for helicopter transport	Sophisticated design and manufacturing know-how	Yes, Bell, others	Probably not	Unknown	Displaces sales from U.S. production sources
Lockheed—Kawasaki (Japan)	License to manufacture military patrol aircraft	Sophisticated navigation systems and manufacturing know-how	Yes, but second choice	Probably similar lines in United Kingdom	Unknown	Probably no displacement
Piper Aircraft—EMBRAER (Brazil)	License to manufacture civilian passenger aircraft	Moderately sophisticated design and production techniques	Yes, Cessna or Beech	Yes, other European sources	Unknown	Increased competition in third country markets, especially African, once Brazilian industry becomes more developed

Source: Developing World Industry and Technology, Inc.

Table 5B

Aircraft Industry

Companies	Technology Transferred	Corporate Considerations	Purchaser Environment	Policy Implications
General Electric—SNECMA (France)	Design and production of high technology; advanced design jet engine for civilian aircraft	Fear of being excluded, even on a partial basis, from lucrative European market U.S. government insists on "measured release" of core technology Need to help pay for high R&D expenditures	Necessity to accept strong foreign partner to obtain internationally competitive technology Strong backing of French government to acquire design and engineering	Possible erosion of U.S. technological lead over French firms as a result of involvement of French design and production engineers Question of whether SNECMA can become major innovator and significant competitive threat to segments of U.S. industry
General Dynamics—European Consortium	Production technology for advanced fighter aircraft, under coproduction arrangement	Sale of technology helps amortize huge R&D costs Need to maintain technological lead to remain internationally competitive	Insistence by purchaser government on coproduction and offset purchase arrangements	Substantial net contribution to U.S. balance of payments, but technology transfer may considerably enhance competitive position of European industry vis-a-vis U.S. firms
Sikorsky Helicopters—VFW Fokker (West Germany)	Production technology for medium transport helicopter	U.S. government defense considerations Development of future supply of low-cost components Sharing R&D expenditures	Government interest in developing national industry and offset sales earnings.	Indication purchaser improving on acquired technology and may become source of future competition
Lockheed—Kawasaki (Japan)	Production technology for military patrol aircraft	Technology sale helped support R&D expenditure by U.S. firm	Government insistence on implanting manufacturing technology with spread effects on supplier industries	No demonstrable loss of jobs or U.S. technological lead at time (late 1950s)
Piper Aircraft—EMBRAER (Brazil)	Production technology for light civil aircraft; assistance in export sales	Need to maintain technological lead and production competitiveness against future Brazilian export capabilities	Piper pre-empted from export by Brazilian import restrictions Brazilian government interest in developing national design and production capabilities	Prospect of Brazil becoming significant exporter of aircraft components (following trend in automotive exports)

Source: Developing World Industry and Technology, Inc.

Table 6A
Automotive Industry

Case Study	Nature of Agreement	Sophistication of Technology	Alternative Sources of Competitive Tech.		Total Remuneration to U.S. Firm	Projected Impact on Other U.S. Producers
			U.S.	Foreign		
General Motors—POLMOT (Poland)	Coproduction of commercial trucks	Highly competitive front-end	Yes	Yes, Europe or Japan	$50 million in potential earnings Sales of vehicle components and replacement parts Sharing in RD&E costs of new model Savings in capital investments of up to $200 million for new line Royalty earnings	Competition in Western European truck market and possibly imports into U.S.
Cummins Engine—Komatsu (Japan)	License to manufacture and comarketing	Highly competitive front-end technology	Probably no	Probably no	Cummins would have had difficulties producing the K engine without Komatsu	Engine parts manufacturers lose out to Japanese producers
Gamma Auto—Socialist country	License to manufacture auto parts	Most sophisticated technology available for particular products	Yes, two U.S. firms	Yes, two former European licensees of Gamma	$47 million Anticipate future sales of equipment, tools, and training not called for in original contract	Competition in Western European and U.S. markets
Swindell-Dressler—USSR	Turnkey construction of truck parts foundry	International competitive facility	Yes, but not "Cadillac" line	Yes, Europe or Japan	Approximately $50 million Sale of parts and components	Competition to auto parts manufacturers in Western Europe
Bendix—Bosch (West Germany)	Cross-licensing of electronic fuel injection system	Advance design product	Yes	Yes	Licensing fees and continuing sharing of technology and components	Competition to U.S. engine sales in Western Europe and possibly U.S.

Source: Developing World Industry and Technology, Inc., 1976.

Table 6B
Automotive Industry

Companies	Technology Transferred	Corporate Considerations	Purchaser Environment	Policy Implications
General Motors—POLMOT (Poland)	Design and production for new line of commercial trucks to be marketed internationally	Opportunity to earn corporate return on Eastern European and segment of Western European markets that would otherwise respectively be inaccessible or require prohibitively high capital investment	Polish government wanted training of technicians and managers in production design operations as well as in engineering POLMOT wanted rapid placement of internationally competitive facility to earn foreign exchange	GM putting a potential competitor into business that may displace U.S. truck exports to Western Europe and eventually even compete in U.S. market with vehicle or truck parts
Cummins Engine—Komatsu (Japan)	Manufacturing technology for advance design diesel engine	Severe capital constraints prompted company to assign major manufacturing responsibilities to former Japanese licensee	Komatsu anxious to take on major manufacturing roles for world market	Erosion of U.S. production jobs yielded to Japanese production facilities U.S. firm shifting investment emphasis away from production and toward marketing and research
Gamma Auto—Socialist country	Manufacturing technology for latest generation automotive bearings	Corporate plan is to develop next generation of manufacturing technology that will cut costs by 40%, before purchaser is ready to enter and compete in international market	Purchaser government anxious to obtain most modern and up-to-date facility to manufacture auto components to internationally competitive standards	Possible erosion of U.S. jobs if purchaser enterprise is able to successfully operate facility and export at competitive prices before Gamma is able to commercialize new auto part Increased competition for U.S. firms in LDC markets
Swindell-Dressler—USSR	Design and engineering of advanced iron foundry facility to supply truck manufacturing complex	S-D is a process engineering arm of the Pullman Corporation and unlike "product" company is not concerned about future competition from facility's output	Evidence Soviets interested in acquiring both operative (turnkey) and duplicative (design-engineering) capabilities	Contribution to industrial complex (automotive) that may in short time compete in international sales of original equipment and automotive replacement parts

Table 6B (continued)

Companies	Technology Transferred	Corporate Considerations	Purchaser Environment	Policy Implications
Bendix— Bosch (Germany)	Licensing of electronic fuel injection system	Necessary to license front-end technology to strong technical partner with dominant market position in order to earn return, to avoid patent infringement claims, and to benefit from technology exchange	German firm able to maintain its technological parity with U.S. firm through cross-licensing arrangement. European auto market demand ahead of U.S. for this technical innovation	Such interchanges advantageous to relative market positions of involved U.S. and German firms, but enhance competitive position of foreign manufacturers vis-a-vis other U.S. firms

Source: Developing World Industry and Technology, Inc., 1976.

Table 7A

Consumer Electronic Industry

Case Study	Nature of Agreement	Sophistication of Technology	Alternative Sources of Competitive Technology		Total Remuneration to U.S. Firm	Projected Impact on Other U.S. Producers
			U.S.	Foreign		
General Telephone and Electronics—SONELEC (Algeria)	Turnkey construction plus manufacturing know-how and managerial training	Package includes standard technology, as well as sophisticated manufacturing know-how	Yes	Yes, French, British and West German firms	$233 million (including $25 million for management training in U.S.)	Possible loss of overseas market, if SONELEC begins to export
Sigma Instruments—Nippon Electric Instruments (Japan)	Cross-licensing for electronic control and instrumentation	Fairly sophisticated technology, which is produced by only a few firms	Yes	Yes, approximately 12 world-wide competitors	Over $1 million per year	Loss of markets because of NEI's success; agreement became competitive liability to Sigma
Motorola—Matsushita (Japan)	Acquisition-license to manufacture patented TV products	Second generation technology, moderate sophistication	Yes	Yes, but Japanese more price-competitive	Purchase price unknown	Reduction of U.S. parts content Displaced by Japanese imports
RCA/Corning—UNITRA (Poland)	License and know-how to manufacture cathode ray tubes	Moderately sophisticated manufacturing techniques	Yes	Yes, especially Japan, but U.S. firm preferred	Over $124 million	No immediate effect on U.S. markets
Fairchild Camera—Kyoto Ceramics (Japan)	License and know-how to manufacture ceramic semiconductors containers	Fairly sophisticated manufacturing technique	Yes (For near alternatives)	Yes (For near alternatives)	$100,000	Kyoto may have proved to U.S. producers that market for containers existed, thereby spurring R&D effort

Source: Developing World Industry and Technology, Inc., 1976.

Table 7B

Consumer Electronics Industry

Companies	Technology Transferred	Corporate Considerations	Purchaser Environment	Policy Implications
General Telephone and Electronics—SONELEC (Algeria)	Turnkey-plus arrangement providing plant construction, manufacturing technology (fully integrated from raw material to radio and TV) and training of full range of managers & technicians	Opportunity to earn substantial return on technology assets without capital resource commitment	Oil revenues permitted government to finance industrial facility Want self-sufficient operational & eventually design engineering to compete in world market	Future competition of Algerian source as supplier of components to Western European market On the positive side, this is new generation of technical assistance developing countries want from U.S. firms & this way affords some political leverage to U.S. foreign policy
Sigma Instruments—Nippon Electric Instruments (Japan)	Complete access to product design and manufacturing know-how for electronic control & instrumentation devices	Maintain controlled release of technology, but Japanese firm began to compete with U.S. firms in third-world country markets	High absorptive capability of foreign partner and supporting industrial environment Rapidly expanding Japanese market	High technical absorptive capability of foreign partner led to rapid development of international competitor
Motorola—Matsushita (Japan)	TV manufacturing plants and patents sold out to Matsushita	U.S. firm decided to phase out its involvement in consumer electronics field in face of mounting R&D costs & intensified competition from foreign (Japanese) imports Acquisition came at time when consumer demand had fallen off in U.S. market	Matsushita gained some manufacturing know-how (less in product design) Company able to expand product line worldwide and rapidly penetrate U.S. market	U.S. firms lose vigor in responding to import challenge Impact on U.S. employment minimum because Japanese firm took over U.S. plant
RCA-Corning—UNITRA (Poland)	Product design, plant engineering, manufacturing know-how, and technical training for cathode ray tubes	Financially remunerative opportunity to earn return on technology asset in otherwise inaccessible market	Polish enterprise interested in internationally competitive production capability to supply domestic & Eastern European market	Long-term (10-year) potential for export of cathode tubes (& TV sets) to Western European and LDC markets
Fairchild Camera—Kyoto Ceramics (Japan)	Manufacturing know-how for ceramic semiconductor packages	Fairchild sold off technology it considered peripheral to its core business	Japanese firm acquired technology for manufacture and export to world markets, including U.S.	U.S. production employment less than what it would have been had the technology been commercialized by U.S. firm

Source: Developing World Industry and Technology, Inc., 1976.

Table 8A

Computer Industry

Case Study	Nature of Agreement	Sophistication of Technology	Alternative Sources of Competitive Tech.		Total Remuneration to U.S. Firm	Projected Impact on Other U.S. Producers
			U.S.	Foreign		
Amdahl—Fujitsu (Japan)	License to manufacture advanced generation of peripheral equipment	Highly sophisticated, internationally competitive	No	No	Because of agreement, Amdahl was able to employ large-scale integrated circuitry in the logic of its computers, thereby surpassing IBM Venture capital	Probable displacement of computer sales by IBM and others in European and other world markets. Also loss of parts manufacture for U.S. market
Honeywell—CII-HB (France)	License to manufacture advance design computer	Highly sophisticated, internationally competitive	Yes	Yes, but second choice	Almost $900 million revenue from operation Access to French public sector market	Possible displacement of U.S. computer sales in Europe and elsewhere
Control Data—ROM-SRL (Roumania)	Joint venture to manufacture computer peripherals	Moderately sophisticated, second generation design	Yes	Yes, but second choice	Access to low-cost labor Guaranteed pretax profit of 10 percent on ROM Control Data's operations Increased entry into Roumanian market	Possible displacement of U.S. subsidiary sales in European markets
Singer—ICL (U.K.)	Acquisition by ICL of Singer's International Business Machines Division Manufacturing rights	Moderately sophisticated, second generation design	Yes	Yes	Singer relieved itself of unprofitable operation	Loss of component exports to European markets
Dataproducts—Videoton (Hungary) Tokyo-Juki (Japan)	License to manufacture computer peripherals	Moderately sophisticated, second or third generation design	Yes	Yes	Export of components Fees and royalties paid	Some displacement of previous U.S. exports to these countries

Source: Developing World Industry and Technology, Inc., 1976.

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Table 8B
Computer Industry

Companies	Technology Transferred	Corporate Considerations	Purchaser Environment	Policy Implications
Amdahl— Fujitsu (Japan)	Manufacturing technology for advance generation peripheral equipment used in conjunction with IBM computers	Inability to obtain venture capital in U.S. market led to association with Japanese firm	Japanese firm anxious to obtain internationally competitive technology to compete in Japanese and other world markets. Strong backing of Japanese government	Acquisition of U.S. technology enhanced Japanese competitive positions in Japan and Europe and provided technology for future penetration of U.S. market
Honeywell— CII-HB (France)	Manufacturing technology and computer design inherited from acquisition of GE computer division	Sole means of obtaining access to French market Guaranteed sales to French government and heavy R&D support for technical development	Financial backing of French government to develop French computer industry to challenge dominant IBM position Anxious to obtain advanced generation of U.S. technology	Technology agreement permits displacement of certain U.S. computer product exports
Control Data— ROM-SRL (Roumania)	Manufacturing technology for computer peripherals	Access to Eastern European market Low-cost procurement source for components exported to Western Europe	Roumanian government interested in coproduction agreements that upgrade technological capabilities and earn foreign exchange for economy	Components procured in Roumania obviates production requirement in U.S.
Singer— ICL (U.K.)	Manufacturing technology for small business computers	U.S. firm unable to compete in this product line; decided to divest marginal earning product groups	UK firm anxious to upgrade its competitive position through acquisition of complementary product line	Competitive position of foreign firms enhanced over other U.S. firms remaining in industry
Dataproducts— Videoton (Hungary) Tokyo-Juki (Japan)	Manufacturing technology for computer peripherals (line printers)	Retained core technology on patented "hammers" for line printer and maintain lagged dependence position	Weak foreign firms satisfied with lagged dependence arrangements	None

Source: Developing World Industry and Technology, Inc., 1976.

Table 9A
Chemical Engineering Industry

Case Study	Nature of Agreement	Sophistication of Technology	Alternative Sources of Competitive Tech.		Total Remuneration to U.S. Firm	Projected Impact on Other U.S. Producers
			U.S.	Foreign		
UOP—Foreign auto firms	License to install catalytic converters on autos for export	Application know-how for fitting converters	Yes	Yes	Unknown	Some possibility of future import competition
Sohio—PRC	License and process know-how for production of acrylonitrile	Sophisticated process logic and catalytic equipment	Yes	Yes	$8 million payment	Little immediate impact; however, Chinese may become competitive in world markets for synthetic fiber
Fluor—Saudi Arabia and Iran	Design and construction of turnkey plants; process licensing and management training	Varying degree of sophistication in process logic and equipment	Yes	Yes	Unknown	Future production of chemical products could compete with U.S. chemical exports
Alpha—Worldwide Transfer	Turnkey-plus	Varying degree of sophistication—high in design logic and "core" equipment	Yes	Yes, especially the Japanese	Unknown	Foreign production could compete with U.S. chemical exports
Beta—Developing countries	Turnkey-plus	Sophistication in management of construction projects	Yes	Yes	Unknown	Little prospect of competition

Source: Developing World Industry and Technology, Inc., 1976.

Table 9B
Chemical Engineering Industry

Companies	Technology Transferred	Corporate Considerations	Purchaser Environment	Policy Implications
UOP— Foreign auto firms with U.S. export markets	Catalysts and catalyst containers for catalytic converters	Process company focuses on the development and sale of successive generations of innovative technology; product firm, the Automotive Division, retains control over technology & manufacture & returns profit factor to company for each unit sold	Foreign auto makers with U.S. export markets compelled by law to install emission control devices to maintain market share	Production jobs and income retained in U.S. as result of UOP's automotive division's management of technology assets
Sohio— People's Republic of China	Process technology for synthetic fiber feedstock (acrylonitrile). Through Japanese engineering intermediary includes plant engineering and training of engineering personnel	Acting here as a process engineering firm (as distinct from product firm with concern over world future market shares), prime consideration is maximizing revenues from technical innovation	PRC anxious to acquire up-to-date operative technology with export potential and at the same time lay base for adaptive engineering of related families of chemical facilities	Proliferation of advanced process design in synthetic fiber field, when linked to textile & clothing fabricating industries in Far East, pose further threat to U.S. exports in this area
Fluor— Iran and Saudi Arabia	Engineering and construction of chemical and petroleum processing facilities, with a strong emphasis on efficient and rapid installation. (Saudi Arabia: a natural gas collection and processing plant; Iran: a series of refineries)	Process and plant engineering firm's basic interest in maximizing returns from sale of design and engineering services anywhere in the world (over half of $10 billion in contracts now overseas). In order to maintain commercial & technological lead in world, firm must improve its cost competitiveness by constantly upgrading its efficiency in project management	Saudi Arabia anxious to expand its domestic processing of oil and natural gas resources Strong drive in Iran to develop local expertise in project management	U.S. employment generated among design and engineering firms and among related capital goods industries, but long-term employment effect on production workers in petrochemicals likely to be undermined

Table 9B (continued)

Companies	Technology Transferred	Corporate Considerations	Purchaser Environment	Policy Implications
Alpha Corporation—(Worldwide Transfer)	Complete turnkey plants, including training of operational personnel in ethylene processing Particularly active in selling advanced process designs for ethylene production	Retains core technology of specially designed equipment that it supplies, rather than releasing manufacturing specifications. The same applies to certain design logic that it does not share with clients	Japanese laws prohibited U.S. firms from practicing in Japan. Japanese purchasers prepared to pay high price for full sets of technical data embodied in equipment drawings, process flow sheets, plant layouts, and operating instructions	The transfer of engineering and design capabilities to Japan has helped develop a strong competitor in the engineering, capital goods, and end product industries serving world markets—partly offset by improved technology resulting from R&D efforts
Beta Corporation—Developing countries	General contractor in petrochemicals, nonferrous metals and minerals, mining, and pharmaceuticals	Unique and proprietary capability in project management systems; utilizes process technology supplied by others. Relies on foreign subsidiary's engineers obtainable at much lower costs	LDC (Chile) interested in developing plant engineering technical personnel—which Beta accomodates to fullest degree possible	U.S. firm provides phased-in engineering capabilities for newly industrializing nations, with little probability of imparting capabilities that will compete with U.S. industries

Source: Developing World Industry and Technology, Inc., 1976.

Table 10

Overview: Industry Trends and Economic Implications

Industry Characteristics and Trends	Leitmotif Cases	Economic Implications
Aircraft High R&D and production-tooling costs and nontariff barriers forcing U.S. firms to share new aircraft design functions and to enter into coproduction agreements to reduce burdensome capital outlays for component production and obtain means to market entry.	GE—SNECMA (France) General Dynamics—European Consortium Sikorsky Helicopters—VFW (West Germany)	(1) Narrowing of technology gap can lead to buildup of potential competition in world markets.
Automotive Emergence of management service contracts in lieu of equity investment as a result of diminishing access to world markets coupled with heightened risks of foreign capital investment and reinforced by the enhanced bargaining power of socialist and other developing countries.	General Motors—POLMOT (Poland) Cummins Engine—Komatsu (Japan) Gamma Auto—Socialist country	See (1) (2) Shifting emphasis from investments in production facilities to marketing and R&D companies.
Computers Mounting R&D costs to develop new generations of products, the dearth of venture capital (particularly for smaller U.S. firms), and intensified foreign competition have forced some firms to withdraw from market and sell residual technology to foreign firms or release advanced technology to foreign enterprises in return for capital funding.	Amdahl—Fujitsu (Japan) Honeywell—CII/HB (France)	See (1) (3) Inability to obtain risk capital in U.S. gives foreign enterprise access to U.S. technology.
Consumer Electronics Increased foreign competition coupled with relative narrowing returns force multiproduct companies to phase out certain product lines and sell off technology, and foreign firms with aggressive commercial expansion capabilities to take over competitive technology. Management service contracts to oil-rich developing countries and socialist (state capitalism) countries a lucrative source of income to U.S. corporations without capital investment.	Motorola—Matsushita (Japan) Sigma Instruments—Nippon Electronic Investments (Japan) General Telephone and Electronics—SONELEC (Algeria) RCA/Corning—UNITRA (Poland)	See (1) (4) Highly effective management service contracts aimed at internationally competitive enterprises help develop future competitors in traditional product lines.
Chemical Engineering Industry furthest advanced in firms that specialize in process design and plant engineering and construction for foreign (and U.S.) enterprises These "design engineering" companies have distinctive "product" companies with interests in maintaining market shares. (See also Swindell-Dressler-USSR)	Alpha—Worldwide Fluor—Saudi Arabia and Iran U.O.P.—Japan Sohio—PRC	See (1) (5) U.S. firms benefit from sale of engineering skills and capital equipment, but force competition from petrochemical plants now proliferating in oil-rich countries including follow-on industries (from synthetic fibers to textiles).

Source: Developing World Industry and Technology, Inc., 1976.

withdraw from the business altogether — General Electric in 1970, RCA in 1971, and Xerox in 1975. Other firms have opted to compete with IBM solely in the production of special-purpose computers or computer peripheral devices.

To overcome these obstacles, firms in the U.S. computer industry have taken measures similar to those taken by U.S. aircraft firms. In exchange for access to foreign markets and an infusion of foreign government funds for developing new generations of technology, the U.S. computer firm is prepared to share its know-how. Small, new computer firms, such as the Amdahl Corporation, find such arrangements particularly compelling during recurring periods of venture capital shortages in the United States. U.S. firms that have earned diminishing returns on their computer assets, and opted to sell out altogether, have found a scarcity of interested U.S. firms and have been forced to sell their operations to foreign enterprises, thereby enhancing their (the latter's) competitive position vis-a-vis the U.S. industry. Most of the purchasers of U.S. computer technology, whether they have acquired it through a joint venture or acquisition, are both highly absorptive and intent on becoming internationally competitive.[5]

The trend of the future in the American automotive industry seems to be toward an increased incidence of management service contracts in lieu of equity investment. This phenomenon is the result of diminishing access to world markets combined with heightened risks of foreign capital investment. In many countries, product take-off as payment for technology and management services is becoming one of the few ways to remit earnings. These considerations are reinforced by an enhanced bargaining position of socialist and other developing countries. Expanding capital requirements to maintain growth and market shares forced some U.S. automotive firms to rethink where their comparative advantage lies. Cummins Engine Co., for example, long a leading manufacturer of high-speed diesel engines, has elected to share a significant portion of the production function for its newest generation diesel engine with its former Japanese licensee, rather than to produce the entire engine in its U.S. facilities. Other U.S. firms, as well, are shifting emphasis from investment in production facilities to marketing and R&D. The never-ending struggle by the U.S. automotive industry to design production systems for a high-wage labor force in competition with low-wage economies with high productivity potential is another important factor contributing to this new phenomenon. While this trend can be expected to be remunerative in the short run to both the U.S. firm involved and the U.S. capital goods industry employed to equip the new facilities overseas, it may result in the long run in an erosion of U.S.-based automotive production, increased foreign competition in world markets, and a consequent loss in blue-collar jobs and income.

The U.S. consumer electronics industry has experienced a severe erosion of its world market share over the past decade — in large part due to aggressive and innovative Japanese competition — coupled with a relative narrowing of returns. Many multiproduct firms in the industry have, as a result, been forced to phase out certain product lines and sell off their technology. Foreign purchasers with the combination of high technical absorptive, and aggressive commercial expansion capabilities have been able to adapt acquired technology and in some cases to shift segments of production to lower wage areas, thereby posing strong competition to other U.S. firms that remain in the industry.

Other active purchasing groups of U.S. electronics technology have been socialist economies and oil-rich developing countries. These two groups have been successful in negotiating highly effective management service contracts aimed at developing internationally competitive enterprises. U.S. firms in the consumer electronics industry may face competition in traditional product lines in their export markets for components once these turnkey operations come on-stream.

The chemical engineering industry, for some decades now, has been in the business of commercializing technology, whether it is embodied in a special process for deriving ethylene from petroleum or embodied in a computerized schedule for engineering and constructing the ethylene facility. Chemical engineering firms have rarely gone through the evolutionary phases in their overseas operations that product-oriented industries have followed: beginning with export and then direct investment to serve protected local markets, followed by licensing to foreign affiliates, and finally, establishing production facilities overseas for export to third-country markets or back to the U.S. market. All of these stages had in common a need on the part of the product firm to retain its technology under parent corporation control, because a return was earned only when the product, based on that technology, was commercialized in the marketplace. The chemical engineering firm, however, earns a return on its technological assets only when it commercializes its technology, and, therefore, seeks to sell newly developed technology as rapidly and extensively as it can and to reinvest a portion of its profits in further R&D. There is little concern for the competitive potential of technology purchasers.

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[5] An analogous set of conditions and consequences have occurred in the nuclear reactor industry. Faced with high R&D costs to develop nuclear reactor technology for commercial use and with domestic demand falling short of anticipations, U.S. firms have sought to amortize investments through licensing arrangements abroad, which, in turn, has led to a proliferation of nuclear reactor technology. Germany, France, and Japan now compete with the U.S. industry as technology suppliers. The worldwide energy crisis, triggered by the rise in petroleum prices, has intensified the demand for nuclear technology by developing countries — Argentina, Brazil, India, Pakistan, and Iran in particular — and countries like Germany are prepared to trade technology on processing nuclear materials and the design and construction of nuclear plants for access to uranium and other fissionable ores and the vast amount of hydroelectric power needed to process nuclear power plant feeder stocks. (See [3].)

The U.S. chemical engineering industry has always had a broad international outlook. In recent years, however, its share of business conducted overseas has increased significantly. This has been due, in large part, to a slack in new construction and expansion of the domestic petroleum and petrochemical industry and the new purchasing power and desire for sophisticated industrial projects in resource-rich developing countries and the socialist economies. Firms in the industry aggressively compete for and cultivate new markets abroad. Many engineering firms have established overseas affiliates in order to be able to bid more effectively on construction contracts. Despite the employment and income gains to be made from this vast market in the process of setting up these plants, the end result will be the proliferation of internationally competitive production capabilities in what have been U.S. export markets for commodities such as synthetic rubber and textiles, plastics, and petrochemical feedstocks.

Major Findings

The following three dimensions of international transfers of industrial technology are among our most salient findings based on case materials. They firmly challenge the viewpoint that decisions made by U.S. corporations in their own self-interest regarding the sale of industrial technology coincide with and protect the interests of the U.S. economy.

1. The role played by the governments of the foreign purchasers of U.S. technology has greatly expanded, thereby lending increased bargaining leverage to the purchasing enterprise in negotiations with American corporations. This role assumes several forms: the erection of nontariff barriers (Honeywell's majority-owned French subsidiary was denied sales to the French government until it merged in a minority position with French computer firm CII) and tariff barriers (the Brazilian government raised tariff on imports of aircraft products already under production in the country from 7 to 50 percent in 1974); acting as the purchaser through state trading companies (the practice in all commercial negotiations in socialist economies); and the provision of generous R&D subsides to national enterprises (in 1971 SNECMA, the French aircraft engine manufacturer, received $200 million in public funds for civilian engine development). Governments provide foreign enterprises a variety of other forms of support, ranging from the subsidization of bidding costs for overseas contracts and cost overruns of overseas jobs to the collection of commercial intelligence in foreign countries and its dissemination to the private sector.

2. The new enterprise-to-enterprise arrangements for transferring late generation technology and production techniques are designed to contribute to rapid and extensive implanting of operative technology to enterprises and economies with even modest absorptive capabilities. The release of proprietary technology is particularly disturbing in a world of intensified competition from astute and aggressive enterprises of industrially advanced countries. In addition, enterprises in industrially advanced countries have become alternative suppliers of first-class, operative technology — a result, in part, of the proliferation of design and manufacturing capabilities by U.S. firms. We found that in at least twenty of the twenty-five case studies, an equally competitive technology was available from foreign enterprises. This has had a bandwagon effect on U.S. firms that now argue if they do not provide the technology, someone else will.

The impetus to release design and manufacturing technology to socialist countries is further reinforced by the U.S. policy of detente. In the case of Eastern European economies, it is contended that technological support leading to internationally competitive industry helps to weaken the political dependence on the USSR. An even stronger argument is put forth regarding the People's Republic of China, where the absorption of advanced technology is viewed as a countervailing force to Soviet power.

3. The foregoing observations provide new and revealing insights on product cycle theory. It is no longer merely mature products and standardized technologies that are moving abroad. Certain U.S. firms, for the various reasons outlined, now feel compelled to release to foreign enterprises their most recently developed technology (in terms of product designs, process engineering, and production systems). In some instances, the "product" has become the implanting of design and engineering capabilities that are the spawning grounds of future industrial competitors.

Implications for the U.S. Economy

Based on our analysis of the case studies, we have identified the following six sets of implications for the U.S. economy.

1. The new generation of management service contracts, coupled with evolving corporate perceptions for maximizing returns on technology assets, may result in a further erosion of U.S. production jobs in key indus-

tries such as automotive, aircraft, consumer electronics, and chemicals. Design engineering and capital equipment industries will benefit from the first-round effects of foreign plant construction; but where the transfers result in internationally competitive facilities and as the plant capacities proliferate, U.S. production and employment could be threatened.

2. These technological displacements could prove particularly troublesome: (a) under adverse domestic economic conditions (low growth rate, high unemployment, inflation, declining productivity, and balance-of-payment difficulties); (b) in the absence of substantial improvement in labor market adjustment mechanisms (to relocate and retrain displaced production workers); and (c) in an economy where technologically dynamic industries (or services) are not expanding at a rate sufficient to absorb labor displacement from declining industrial sectors. The shift from the low skill range of production jobs to higher skill technical support requirements poses additional manpower adjustment problems.

3. A permissive posture in the release of front-end technology to commercially astute and aggressive foreign enterprises can prove to have especially damaging consequences for other U.S. producers in that industry. Not only can there be anticipated an erosion in the U.S. market share in newly developing regions, but also in the most industrially advanced export markets. The Amdahl-Fujitsu joint venture is an excellent case in point. It has been estimated that the infusion of Amdahl's technology has allowed Fujitsu to close approximately a three-to-five year technological gap between it and the U.S. industry. By 1970, the Amdahl-Fujitsu joint venture can sell a sufficiently large number of 150 systems in North America, Western Europe and Japan to displace more than $500 million in revenue to IBM. Furthermore, Fujitsu is now negotiating with several German computer firms to establish joint ventures to enter European markets.

4. There is some evidence that U.S. firms are encountering increasing difficulties in adjusting to technical change and are considering the marketing of their technology as an alternative to aggressively engineering for competitive production in the high-wage U.S. economy. In the Cummins Engine-Komatsu case, the corporate decision was to allocate major manufacturing responsibility for its most advanced engine line to a strong, successful Japanese firm (formerly, a licensee), because of the faltering proficiency of production in the United States and the cyclical difficulty of raising expansion capital in the United States. The dearth of venture capital was a determinant factor in the substantial release of front-end technology in the Amdahl-Fujitsu case.

5. The proliferation of internationally competitive, industrial technology to Japan, Western Europe, and socialist economies may be weakening the bargaining position of U.S. firms as suppliers of technology to newly industrializing countries and in trade negotiations with these countries. Japan has become a technological intermediary for many countries of the developing world, having absorbed and adapted segments of U.S. technology. The socialist countries may follow suit in time, depending on the volume of transfers and the efficiency of implantation. These trends in the world economy add to the continuing necessity for U.S. industry to maintain technological leads through investments in R&D and the commercializing of technical innovation *within the U.S. production system* (as distinct from the tendency to move abroad as it becomes difficult to maintain production competitiveness in the U.S. economy).

6. Technological partnerships with industrial enterprises in developing countries (such as Algeria and Brazil) could be mutually beneficial. Until such time as the technology and managerial gaps are considerably narrowed, U.S. enterprises can continue to export U.S.-manufactured goods, engineering services, and capital equipment. In a changing world economy in which developing countries take an expanding share in the international division of labor for manufactured goods, the United States will continue to shift to the capital-intensive range of manufacturing, relinquishing the more labor-intensive segments of production to lower-wage countries. These shifts, however, place an added burden on U.S. labor market adjustment mechanisms.

A final note of caution may be in order. The evidence presented in the case material is an early warning of what may prove to be emerging trends in the international economy — an enlarged mobility of technology in international trade, the importance of technological diffusion in changing patterns of comparative advantage, and the intensified competition among suppliers of technology. If these trends materialize and they prove to be of significant proportions, it may mean an intensified set of problems for the U.S. economy in adjusting to these international shifts in comparative advantage. The emphasis in the analysis has been upon the identification of factors and trends that *could* prove harmful to the U.S. economy. Whether or not these factors and trends do prove harmful, *on balance*, depends upon offsetting factors and response mechanisms within individual firms and other impacted firms elsewhere in the economy. For example, the earnings generated by technology sales could result in new and more competitive industry, and the newly industrialized nations that benefit from the purchase of our technology could expand demand for U.S. exports.

To assess the net effect of the economic forces at play would require sector and general equilibrium analysis, which is well beyond the scope of this study. We have, therefore, stopped short of definitive policy recommendations. Even if the individual events cited in the cases proved to be significant trends within the economy, there is basic disagreement among economists on intervention mechanisms, and indeed whether on balance any intervention in the long run can prove beneficial (see, for example [6]).

Literature Cited

1. Baranson, Jack. *Manufacturing Problems in India: The Cummins Diesel Experience*. Syracuse: Syracuse University Press, 1967.
2. Defense Science Board Task Force on Export of U.S. Technology. *An Analysis of Export Control of U.S. Technology—A DOD Perspective*. Washington: U.S. Department of Defense, February 1976.
3. Gall, Norman. "Atoms for Brazil, Dangers for All." *Foreign Policy*, 23 (Summer 1976), 155–201.
4. General Accounting Office. *The Government's Role in East-West Trade—Problems and Issues*. Summary Statement of Report to the Congress, February 4, 1976.
5. Hall, George A., and Robert E. Johnson. "Transfers of United States Aerospace Technology to Japan." In *The Technology Factor in International Trade*, edited by Raymond Vernon. A Conference of the Universities—National Bureau Committee for Economic Research. New York: Columbia University Press, 1970.
6. Johnson, Harry G. "Technological Change and Comparative Advantage: An Advanced Country's Viewpoint." *Journal of World Trade Law*, 9 (January-February 1975), 1–14.

Comment

T. Norman Van Cott

In Jack Baranson's view, technology transfers by U.S. firms may (1) cause an erosion of job opportunities in key industries in the United States, and (2) weaken the competitive position of U.S. suppliers of technology. Baranson admits the paper is one-sided. The emphasis in his twenty-five case studies is almost entirely on aspects of technology transfers that are harmful to U.S. economic interests, to the neglect of beneficial effects.

But one-sidedness aside, my major criticism is that he misinterprets his evidence. He concludes that there is a causal relation between the harmful effects he describes and the transfers themselves. But the evidence does not support this conclusion. In at least twenty of the twenty-five case studies, Baranson observes that U.S. firms faced foreign competition. For these cases, even if the American firms had been prohibited from engaging in technology transfers, the actions of foreign technology sources in marketing their technology and recipients selling the resulting products for home consumption or export would have led to harmful effects similar to those Baranson describes. By directing attention to the counterfactual implications of Baranson's evidence, it is exposed as incapable of confirming the proposition that the technology transfers he considers harmed U.S. interests. Curbing technology export activity in the face of competitive pressures will not avoid the harmful effects, and with no gains realized from the technology exports, the forfeited export revenue would impose a net burden on the United States. There would not be any "good news" to offset the "bad news." Baranson's failure to focus on the implications of the foreign competition issue is a critical oversight on his part, since it risks reversing the thrust of his argument about the desirability of technology transfers.

In those technology markets where a number of U.S. firms possess world monopoly power, specific restrictions to prevent these firms from competing this national advantage away may prove profitable. In such cases Baranson's conclusion is at least plausible. As Baranson suggests, however, the trend of the last several decades is toward increasing world competition in technology, with a concomitant decrease in U.S. market power. Consequently we should be cautious about the current prospects for such gains, whatever past opportunities might have been. Withdrawing from the world market after competitive conditions emerge is analagous to paying a toll for shutting the gate after the horse is out. Professor Harberger has argued that real world competitive forces are so strong that we could not build a very effective gate to keep our technological advantages at home in any event.

In addition to the foreign competition issue, I find Baranson's analysis marred by other defects. For example, in seventeen of the twenty-five case studies, the royalty or payment received by the U.S. firm is at best only vaguely described. In what is basically a paper about firm behavior with respect to technology, it is curious that the price of technology does not enter as a consideration for the supplier enterprise in Baranson's analytical model as illustrated by Table 2 in his paper. Yet if the technology transfers Baranson discusses actually cause adverse employment effects or a loss of competitive edge, is it not conceivable that the royalty could more than compensate for the damage? Surely there is some royalty that would! Baranson does not even consider the possibility. Although the "What's good for General Motors is good for the country" criteria for social policy has been discredited, one should not totally disregard the firm's interests. It is an appropriate part of the cost-benefit calculations, difficult as that exercise may appear judging from Baranson's concluding comments.

Comment

Arnold C. Harberger

Let me begin by congratulating both the organizers for their wise choices and the authors themselves for the high level of professionalism and technical competence that the papers demonstrate. This makes it a pleasure to be a discussant, and at the same time tempts the discussant to take a wide-ranging strategical approach, rather than carp at tactical or technical details. As you will see, I have found it easy to succumb to that temptation.

I was lucky, I think, in my choice of the order in which I read the papers: First, Frank and Freeman, then Horst, and finally, Baranson; for as it worked out, each subsequent paper helped me move further along the line of thought on which I had left the previous one.

On the Frank-Freeman paper, I was pleased by the sophistication with which they dealt with the labor market, and in a way, gratified to learn how relatively well our economy seemed to work in absorbing the unemployment induced by shocks in the foreign trade and investment sectors. The authors state that "protracted periods of joblessness are not one of the major welfare costs associated with the overseas transfer of production activities." This statement is amply confirmed by their Table 6, which shows the average duration of indirect unemployment associated with these shocks to range between four and eight weeks, and by Table 5, which estimates that more than half of those initially displaced are reabsorbed within six weeks.

The long-run picture emerging out of their section 4, however, is much more disturbing. There, it appears that a prohibition of direct foreign investments could lead to a rise of 3 to 10 percent in U.S. labor income, and of up to 4 percent in U.S. national income. These are big numbers; even if it is recognized that such differences in measured income are likely to overestimate significantly the differences in economic welfare involved. You should recall that I have been engaged in welfare cost estimation for many years, working with monopoly, the U.S. tax system in general, the corporation income tax in particular, measures of the costs of economic distortions in other countries, etc. I never got numbers as large as those obtained by Frank and Freeman. So I am impressed.

Frank and Freeman's results have powerful policy implications that go in a direction antithetical to the conventional wisdom of economics. Are we to take them seriously? If so, how can we avoid following them to their apparent policy implication of prohibiting foreign investment? And if we are not going to take them seriously, on what basis?

I, for one, do not believe that serious empirical and theoretical work, competently carried out, should be dismissed merely on the basis that the results do not accord with our preconceptions. My own reaction to the results was to try to relate them to my own thoughts and observations on the international flow of capital. This (the international capital market) is the place where the experience of other countries touches most directly on the subject matter of today's session.

To make a long story short, the evidence points to the existence of a single grand capital market, covering at least the great bulk of the non–Communist world. Within this capital market the rates of return on investments have a tendency to be held within a relatively narrow band. I have estimated national aggregate rates of return to capital for some twenty countries, and they show an amazing degree of similarity. Moreover, there is no strong tendency for the rate of return to be higher in poor than in rich countries. Thailand's rate of 7.3 percent is close to Germany's (7.1 percent), and Colombia's (7.8 percent) is close to Belgium's (7.9 percent). The average rate for eleven less-developed countries (8.7 percent) is close to those of the U.S. (8.5 percent) and Canada (8.4 percent).

The most plausible explanation for these observations is that capital flows with relative ease among the countries concerned. In many cases it is free to move; in others there are legal obstacles. But it seems that even where the legal obstacles are numerous and strong, the ingenuity of economic agents overcomes the assiduity of the bureaucrats, and capital nonetheless flows quite freely. On the basis of a rather systematic though informal poll of knowledgeable people in the Indian financial community, for example, capital flows freely over the black market between Bombay and Europe, and Indian investors in the Eurocurrency market earn essentially the Eurodollar rate. In Latin America there is widespread evidence of capital flight (mainly through underinvoicing of exports and overinvoicing of imports) when the local situation becomes precarious (or nonremunerative), and of a reflux of funds when local conditions return to "normal."

Taking the above evidence at face value, I believe that international capital flows can be likened to movements of subsurface water. Though there are some differences in the level of water, due to the different characteristics of soil and rock formations, etc., there is still a strong and dominant tendency for the water in any place to find its natural level.

I think it is the same with the rates of capital in different places. Some rates of return may be higher than others owing to conditions of risk, location, etc. But dramatic differences are hard to find, and the best available evidence suggests that attractive new investments will create a sort of suction, drawing funds from other parts of the market, or diverting funds that would otherwise have gone elsewhere. In the end, the new investment opportunities will be financed in large measure from the world capital market. If it were not so, we would observe far more dramatic and persistent difference in rates of return than we normally do.

Where does all this lead us? How is it relevant to this topic of foreign investment? As I see it, the key is that the policy implication of the Frank-Freeman paper, of cutting off direct private investment abroad, becomes other-worldly. If one tried to prohibit foreign investment the flows in question would simply find new channels. My guess is not that the location of production would be totally unaffected. Barriers cannot be got around costlessly. But strong real economic forces would continue to influence the location of production in a basically unaltered way.

The other papers have some bearing on this issue. Horst points out, on p. 141, that in actual practice, U.S. production is often a remote and distant alternative to foreign investment; and Baranson shows how many different kinds of relationships the multinational firms have entered into as alternatives to the more traditional direct investment.

As I was reading the Frank-Freeman paper, my imagination immediately went to possibilities such as the American firms providing licensing and the American capital market providing debt capital, with this combination supplanting the more traditional kind of direct investment. But Baranson shows that the actual relationships have been far more complicated and incredibly more ingenious than I had known.

I draw very different conclusions from those of Baranson, however. He seems to suggest that these various types of relationships might appropriately be regulated. My own reaction is that it would be absurd to try to do so. If direct investment is regulated, licensing is going to do much the same thing. If some disadvantages appear to licensing, management service contracts will accomplish much the same objective. And if the government tries to clamp down on management service contracts, there is still nothing to prevent the same or similar individuals from being contracted directly, and personally, by the foreign firms to do much the same work.

And after all is said and done, one can simply reconstitute multinationals, or pieces of them, as Panama or Liberia corporations totally outside U.S. jurisdiction except as far as their U.S. operations are concerned. So let's not kid ourselves.

In any event, I am troubled by the attitude that considers such regulation as a plausible line of policy. As I can see it, international movements of capital and technology are a lot harder to prohibit than the consumption of alcoholic beverages was in the United States during the Prohibition years. And in a deep sense, I am worried by it. Even if foreign investment could be effectively prohibited and even if this raised U.S. income, the policy would violate some fundamental goals that I think are widely shared in the free world.

If there is any single thing that will help lift the poorer two-thirds of humanity out of its present poverty and misery, it is the application of modern technology. I just do not want to see it accepted as a tenet of our public and social values that the U.S. would, as a matter of national policy, limit the spread of technology around the world, trying, as it were, to exploit our national monopoly position even beyond what individual firms do in the pursuit of their own self-interest. I really would feel a sense of shame if we ended up instituting the very kind of international trade and investment policies that, as carried on by Great Britain, prompted the American Revolution two centuries ago.

Reply

Jack Baranson

T. Norman Van Cott's comments allow me an excellent opportunity, on the one hand, to acknowledge some deficiencies in the study, and, on the other, to correct some misconceptions that have arisen concerning my analysis. What I have reported is that the *transfer of latest generation technology by U.S. firms to noncontrolled foreign enterprises* may, in Mr. Van Cott's words: (1) cause an erosion of job opportunities in key industries in the United States, and (2) weaken the competitive position of United States suppliers of technology, *over the long term*. That final qualifier is significant and, in fact, carries several other important qualifiers:

> (a) under adverse domestic economic conditions (low growth rate, high unemployment, inflation, declining productivity, the balance-of-payment difficulties); (b) in the absence of substantial improvement in labor market adjustment mechanisms (to relocate and retrain displaced production workers); and (c) in an economy where technologically dynamic industries (or services) are not expanding at a rate sufficient to absorb labor displacement from declining industrial sectors.

The case studies may be faulted for not sufficiently recognizing the first and second round of beneficial effects that accrue to the U.S. economy as a result of technology transfers. Most of the case analyses do, however, point to the employment and national income generated among U.S. capital goods and engineering firms in constructing and equipping new manufacturing facilities overseas and among the suppliers of technology that are called upon to export, before start-up operations begin, finished products and later, parts and components not produced by the technology purchaser. Also, if not explicit, implicit in the case write-ups is the recognition that a willing and qualified alternative foreign source of comparable technology existed. And, furthermore, if the U.S. firm refrained from selling the technology, these first and second rounds of benefits would be denied the economy and any long-term adverse consequences would be suffered in any event.

I fully appreciate both Mr. Van Cott's and Professor Harberger's clever analogies on the futility and counterproductivity of U.S. government attempts to control the flow of technology across national boundaries. It has not been my intent to suggest that I advocate such measures. What I have called for are *improved early warning systems* of adverse impacts so that timely adjustments can be implemented in those indicated industries and in the economy at large.

Finally, I agree with Mr. Van Cott that a greater knowledge of royalty payments would have been extremely valuable to our analysis; however, the expectation that U.S. firms would reveal precise figures on particular royalty revenues for a public document is slightly naive. Such information, in most cases, is considered highly proprietary by the firm. In the absence of specific data, we can safely assume that most suppliers of internationally competitive technology are generously compensated for its release. And, if U.S. firms employ those revenues to generate more competitive technology or to employ more workers productively, most adverse consequences would be offset.

I do believe Professor Harberger is mistaken in his judgments on the *need* and public interest in controlling the activities of MNCs and in the *potential* for effective action in this area — both from the U.S. and LDC viewpoint. Government intervention in foreign enterprise involvements in Japan was a major contribution to the growth and dynamics of Japanese enterprise. I believe similar efforts in Brazil, Mexico, and other newly industrializing nations — when judiciously conceived and applied — have contributed to the dynamic growth and development of their national industries.

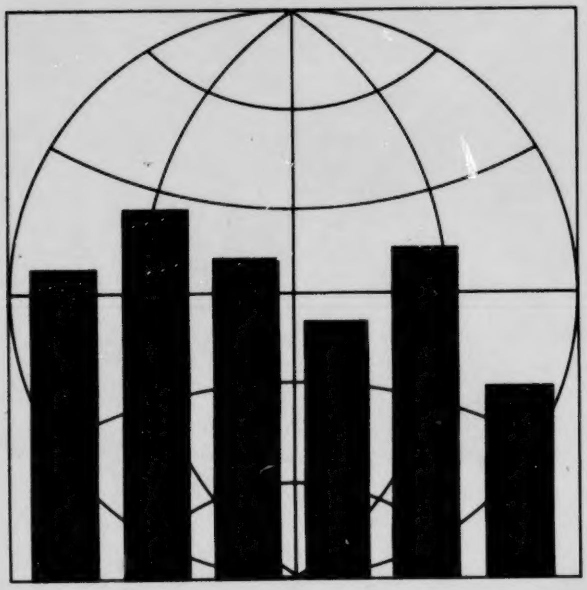
From the U.S. viewpoint, I believe that the new generation of massive transfers of operational technology by U.S. corporations based upon commercial considerations to noncontrolled foreign enterprise should now be viewed in the larger context of impacts on the U.S. economy. I have gone a bit further in spelling out U.S. economic policy implications of the DOL study in [1].

Literature Cited

1. Baranson, Jack. "Technology Exports Can Hurt Us." *Foreign Policy*, no. 25 (Winter 1976–77), 180–95.

Part Five

International Productivity Comparisons



Introduction

Donald F. Gordon

The largest part of the research initiated by the Bureau of International Labor Affairs, which has been reported at this conference, has concerned the short-run dislocations and employment effects of rather sudden changes in trade flows. I think this is as it should be. The costs of such changes are very real to the individuals who suffer, and are properly of concern to legislators. Moreover such questions have been woefully neglected in the textbook and other standard literature, where one smoothly slides up or down on supply and demand curves.

However, as a result of this proper emphasis a casual observer of these proceedings might get the impression that we regard exports as good and imports as bad. This, of course, is not so. It is still true that in the long run imports raise our standard of living and that exports are ultimately only worthwhile because they enable us to buy these imports. It is perhaps easier today than it was four years ago to see this. In the interim we had one sharp crisis over a lack of oil imports, and another over a surge in grain exports.

The international trade of the United States has expanded rather spectacularly over the past few years, and the benefits to the American worker of this expansion would not have been possible without the impressive increases in productivity in many foreign economies. Some of the sources of this productivity relative to the United States, for several countries, is the subject of the study to be presented and discussed this morning.

There are at least three reasons why labor — that is nearly all of us — should be interested in comparative international productivity. First, as already alluded to, increased foreign productivity makes other countries better suppliers of goods for us and, what is the other side of the same coin, better customers for our goods. It is only in minor respects that we should envisage two large trading nations as competing as, say, two neighboring hamburger stands — the type of notion behind much popular thinking. A more correct analogy would be the agricultural and manufacturing industries of the United States, providing each other with goods and markets for goods. Both thrive individually when the other is more productive.

Second, the more we understand about growth processes the more we can explain our own rather modest rate of growth. To some extent we may be able to learn something that will improve our performance. This cannot, of course, be quaranteed. But it is important to remember that even a minor change in productivity improvement — compound interest being what it is — will result in a much greater gain in real wages and welfare than short-run disturbances will cost.

Finally, comparative productivity studies show up this latter fact. They free us from the tyranny of the journalist's conception of economic problems, which emphasizes price changes, monetary crises, exchange rate crises, and other superficial or ephemeral phenomena. These must concern political leaders, and they do make headlines, but they are basically of secondary importance compared to productivity. Let me cite but one example. Everyone "knows" from several years of panic headlines that the Italian economy is the "sick man of Europe." Who would guess that in fact, as reported in my latest edition (1976) of the *Statistical Abstract of the United States*, real hourly wages in Italian manufacturing rose 73 percent from 1967 to 1974? This was much the highest increase among western European industrialized countries, and compares with a 5.5 percent increase in the United States for the same period.

For these kinds of reasons I believe we should be interested in the results of the recent and relatively sophisticated research on the determinants of productivity change by Professors Christensen and Jorgenson.

Productivity Growth, 1947–73: An International Comparison

Laurits R. Christensen, Dianne Cummings, and Dale W. Jorgenson*

1. Introduction

The purpose of this paper is to provide an international comparison of postwar patterns of productivity growth for the United States and eight of its major trading partners — Canada, France, Germany, Italy, Japan, Korea, the Netherlands, and the United Kingdom. Our study covers the period 1947–73 for the United States and as much of this period as is feasible for each of the eight remaining countries. We compare growth in output and growth in output per hour worked for all nine countries for the period 1960–73. For all countries except Korea we compare productivity growth during this period with productivity growth beginning earlier and extending through 1960.

A complete analysis of productivity growth includes the growth of real product and its sources: growth in real factor input and in total factor productivity. Growth in real factor input must be further divided between growth in real capital input and in real labor input. Growth in labor input involves growth in hours worked and growth in real labor input per hour worked, which we denote the quality of hours worked. Growth in capital input involves growth in capital stock as a component of wealth through saving and capital formation and growth in real capital input per unit of capital stock, which we denote the quality of capital stock.

In section 2 we present our methodology for measuring real product, real factor input, and total factor productivity. This methodology, based on the economic theory of production, begins with a production function giving output as a function of capital input, labor input, and time. We derive index numbers for real product, real capital input, real labor input, and total factor productivity. We express the rate of growth of real product as the sum of the growth rate of total factor productivity and a weighted average of growth rates of real capital input and real labor input. We provide descriptive measures of hours worked, capital stock, capital quality, and labor quality. Using these descriptive measures, we express the growth rate of output per hour worked as a weighted sum of the growth rates of the quality of hours worked, the quality of capital stock, capital stock per hour worked, and total factor productivity.

In section 3 we outline the empirical implementation of our index numbers for real product, real factor input, and total factor productivity for the nine countries included in our study. In section 4 we present an international comparison of patterns of productivity growth for all nine countries. Our first finding is that, for 1960–73, differences in growth rates of real product are associated with differences in growth rates of real factor input, and that, for a given country during this period, growth rates of real product different from those of earlier periods are associated with differences in growth rates of real factor input. Our second finding is that growth rates of output per hour worked are associated with growth rates of real factor input per hour worked among countries for a given time period and between time periods for a given country. We present a more detailed summary of our conclusions in section 5.

2. Methodology

Introduction

Our first objective is to separate growth in real factor input from growth in total factor productivity in accounting for growth in real product for each of the nine countries included in our study. For this purpose we require a methodology for measuring real product, real factor input, and total factor productivity. Our methodology is based on the economic theory of production and technical change. The point of departure for this theory is a production function giving output as a function of capital and labor inputs and time. We consider production under constant returns to scale, so that a proportional change in all inputs results in a proportional change in output.

In analyzing changes in production patterns, we combine the production function with necessary conditions for producer equilibrium. We express these conditions as equalities between changes of each input in the value of output and the elasticity of output with respect to that input. The elasticities depend on inputs and time, the variables that enter the production function. To analyze changes in the pattern of production with time we consider the rate of technical change, defined as the rate of growth of output, holding all inputs constant. The rate of technical change, like the elasticities of output with respect to input, depends on inputs and time.

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*This paper is based on Laurits R. Christensen and Dale W. Jorgenson, "Measuring Economic Performance: 1947–1973" under contract ILAB 73-6 which was completed in 1975.

Index Numbers

Our methodology for productivity measurement is based on a specific form of the production function F:

$$\begin{aligned} Y = \exp[&\alpha_0 + \alpha_K \ln K + \alpha_L \ln L + \alpha_T T \\ &+ \tfrac{1}{2}\beta_{KK}(\ln K)^2 + \beta_{KL} \ln K \ln L + \beta_{KT} \ln K \cdot T \\ &+ \tfrac{1}{2}\beta_{LL}(\ln L)^2 + \beta_{LT} \ln L \cdot T + \tfrac{1}{2}\beta_{TT}T^2]. \end{aligned}$$

For this production function, output is a transcendental or, more specifically, an exponential function of the logarithms of inputs. We refer to this form as the transcendental logarithmic production function or, more simply, the translog production function.[1]

The translog production function is characterized by constant returns to scale if and only if the parameters satisfy the conditions

$$\begin{aligned} \alpha_K + \alpha_L &= 1, \\ \beta_{KK} + \beta_{KL} &= 0, \\ \beta_{KL} + \beta_{LL} &= 0. \end{aligned}$$

The value shares of capital and labor input can be expressed as

$$\begin{aligned} v_K &= \alpha_K + \beta_{KK} \ln K + \beta_{KL} \ln L + \beta_{KT}T, \\ v_L &= \alpha_L + \beta_{KL} \ln K + \beta_{LL} \ln L + \beta_{LT}T. \end{aligned}$$

Finally, the rate of technical change can be expressed as

$$v_T = \alpha_T + \beta_{KT} \ln K + \beta_{LT} \ln L + \beta_{TT}T.$$

If we consider data at any two discrete points of time, say T and $T-1$, the average rate of technical change can be expressed as the difference between successive logarithms of output less a weighted average of the differences between successive logarithms of capital and labor input with weights given by average value shares

$$\begin{aligned} \ln Y(T) - \ln Y(T-1) = {} & \bar{v}_K[\ln K(T) - \ln K(T-1)] \\ &+ \bar{v}_L[\ln L(T) - \ln L(T-1)] \\ &+ \bar{v}_T, \end{aligned}$$

where

$$\begin{aligned} \bar{v}_K &= \tfrac{1}{2}[v_K(T) + v_K(T-1)], \\ \bar{v}_L &= \tfrac{1}{2}[v_L(T) + v_L(T-1)], \\ \bar{v}_T &= \tfrac{1}{2}[v_T(T) + v_T(T-1)]. \end{aligned}$$

We refer to this expression for the average rate of technical change v_T as the translog index of technical change.

We can also consider specific forms for the functions defining aggregate output Y, capital input K, and labor input L. For example, the translog form for aggregate output as a function of its components is

$$\begin{aligned} Y = \exp[&\alpha_1 \ln Y_1 + \alpha_2 \ln Y_2 + \cdots + \alpha_m \ln Y_m \\ &+ \tfrac{1}{2}\beta_{11}(\ln Y_1)^2 + \beta_{12} \ln Y_1 \ln Y_2 + \cdots \\ &+ \tfrac{1}{2}\beta_{mm}(\ln Y_m)^2]. \end{aligned}$$

The translog output aggregate is characterized by constant returns to scale if and only if

$$\begin{aligned} \alpha_1 + \alpha_2 + \cdots + \alpha_m &= 1, \\ \beta_{11} + \beta_{12} + \cdots + \beta_{1m} &= 0, \\ \vdots \quad\quad \vdots \quad\quad\quad \vdots \quad & \quad \vdots \\ \beta_{1m} + \beta_{2m} + \cdots + \beta_{mm} &= 0. \end{aligned}$$

The value shares of individual outputs $\{w_{Y_i}\}$ can be expressed as

$$w_{Y_i} = \alpha_i + \beta_{1i} \ln Y_1 + \cdots + \beta_{im} \ln Y_i, \quad (i = 1,2, \ldots, m).$$

Considering data at discrete points of time, the difference between successive logarithms of aggregate output can be expressed as a weighted average of differences between successive logarithms of individual outputs with weights given by average value shares

$$\ln Y(T) - \ln Y(T-1) = \Sigma \bar{w}_{Y_i}[\ln Y_i(T) - \ln Y_i(T-1)],$$

where

$$\bar{w}_{Y_i} = \tfrac{1}{2}[w_{Y_i}(T) + w_{Y_i}(T-1)], \qquad (i = 1,2, \ldots, m).$$

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[1] The translog production function was introduced by Christensen, Jorgenson, and Lau [7, 8]. The treatment of technical change outlined below is from Jorgenson and Lau [15].

Similarly, if aggregate capital and labor input are translog functions of their components, we can express the difference between successive logarithms in the form

$$\ln K(T) - \ln K(T-1) = \Sigma \bar{v}_{Kj} [\ln K_j(T) - \ln K_j(T-1)],$$

$$\ln L(T) - \ln L(T-1) = \Sigma \bar{v}_{Lk} [\ln L_k(T) - \ln L_k(T-1)],$$

where

$$\bar{v}_{Kj} = \tfrac{1}{2}[v_{Kj}(T) + v_{Kj}(T-1)], \qquad (j=1,2, \ldots, n);$$

$$\bar{v}_{Lk} = \tfrac{1}{2}[v_{Lk}(T) + v_{Lk}(T-1)], \qquad (k=1,2, \ldots, \mathrm{p}).$$

We refer to these expressions for aggregate output, capital input, and labor input as *translog indexes of output, capital input, and labor input*.[2]

To define price indexes corresponding to translog indexes of aggregate output, capital input, and labor input, we employ the fact that the product of price and quantity indexes for each aggregate must be equal to the sum of the values of the components of the aggregate. For example, the price index for aggregate output is defined as the ratio of the sum of the values of the individual outputs to the translog output index. Price indexes for capital and labor input can be defined in a strictly analogous way. Although the resulting aggregate price indexes do not have the form of translog index numbers, these price indexes are nonetheless well defined. Each aggregate price index can be determined solely from data on prices and quantities of the components of the aggregate. By definition the product of price and quantity indexes for an aggregate is equal to the sum of the values of its components. However, these indexes do not have the reproductive property that a translog index of translog indexes remains a translog index. The translog index for an aggregate depends on the structure of the subaggregates on which it is defined.[3]

Productivity Change

Our methodology for separating growth in real factor input from growth in total factor productivity is based on translog index numbers of aggregate output, capital input, labor input, and technical change. These index numbers provide a direct connection between the economic theory of production and technical change and data on prices and quantities of output and input at discrete points of time. We find it useful to develop further implications of our methodology for data on capital and labor input. The measurement of capital input begins with data on the stock of capital for each component of capital input. Similarly, the measurement of labor input begins with data on hours worked for each component of labor input. It is important to be explicit about the relationship between these data and the aggregates for capital and labor input defined by translog index numbers.

For a single type of capital input we first characterize the relative efficiency of capital goods of different ages by means of a sequence of nonnegative numbers — $d(0), d(1), \ldots$ We normalize the efficiency of a new capital good at unity, $d(0) = 1$, so that the remaining elements in the sequence represent the efficiency of capital goods of every age relative to the efficiency of a new capital good. We assume that relative efficiency is nonincreasing with age, say τ, so that

$$d(\tau) - d(\tau-1) \leqslant 0, \qquad (\tau=1,2, \ldots),$$

and that every capital good is eventually retired or scrapped, so that relative efficiency eventually drops to zero.

$$\lim_{\tau \to \infty} d(\tau) = 0.$$

The stock of capital, say $A(T)$, is the sum of past investments, say $I(T-\tau)$, each weighted by relative efficiency.

$$A(T) = \sum_{\tau=0}^{\infty} d_\tau \, I(T-\tau).$$

Similarly, the price of acquisition of new capital goods, say $p_I(T)$, is the discounted value of the future prices of capital input, say $p_K(T+\tau)$, weighted by relative efficiency.

$$p_I(T) = \sum_{\tau=0}^{\infty} d_\tau \prod_{S=1}^{\tau} \frac{1}{1+r(T+S)} \, p_K(T+\tau+1),$$

where $r(T)$ is the *rate of return on capital* in period T and

$$\prod_{S=1}^{\tau} 1/[1 + r(T+S)]$$

is the discount factor in period T for future prices in period $T+S$.

---

[2] The quantity indexes were introduced by Fisher [11] and discussed by Tornquist [18], Theil [17], and Kloek [16]. These indexes of output and input were first derived from the translog production function by Diewert [illegible]. The corresponding index of technical change was introduced by Christensen and Jorgenson [6]. The translog index of technical change was first derived from the form of the translog production function given above by Diewert [10] and by Jorgenson and Lau [15]. Earlier Diewert had interpreted the ratio of translog indexes of output and input as an index of technical change under the assumption of Hicks neutrality.

[3] This corrects an error in [5, p. 261].

Using data on decline in efficiency, estimates of capital stock can be compiled from data on prices and quantities of investment in new capital goods at every point in time by means of the perpetual inventory method.[4] We assume that relative efficiency of capital goods declines geometrically with age:

$$d_\tau = (1-\delta)^\tau, \qquad (\tau = 0, 1, \ldots).$$

Under this assumption capital stock is a weighted sum of past investments with geometrically declining weights.

$$A(T) = \sum_{\tau=0}^{\infty} (1-\delta)^\tau I(T-\tau).$$

Similarly, the price of investment goods is a weighted sum of future prices of capital input with the same weights.

$$P_I(T) = \sum_{\tau=0}^{\infty} (1-\delta)^\tau \prod_{S=1}^{\tau} \frac{1}{1+r(T+S)} p_K(T+\tau+1).$$

Capital stock at the end of each period is equal to investment during the period less a constant proportion δ of capital stock at the beginning of the period.

$$A(T) = I(T) - \delta A(T-1).$$

Similarly, the price of capital input is equal to the sum of the nominal return to capital $p_I(T-1)r(T)$ and depreciation $\delta\, p_I(T)$, less revaluation $p_I(T) - p_I(T-1)$.

$$p_K(T) = p_I(T-1)r(T) + \delta p_I(T) - [p_I(T) - p_I(T-1)].$$

We can also express the price of capital input as the sum of the price of investment $p_I(T-1)$ multiplied by the *own rate of return on capital* $r(T) - [p_I(T) - p_I(T-1)]/[p_I(T-1)]$ and depreciation

$$p_K(T) = p_1(T-1)\left[r(T) - \frac{p_I(T) - p_I(T-1)}{p_I(T-1)}\right] + \delta\, p_I(T).$$

Second, for each of the components of capital input $\{K_j(T)\}$ the flow of capital services is proportional to the stock of capital at the end of the preceding period, say $\{A_j(T-1)\}$,

$$K_j(T) = Q_{Kj} A_j(T-1), \qquad (j = 1, 2, \ldots, n),$$

where the constants of proportionality $\{Q_{Kj}\}$ transform capital stock into a flow of capital services per period of time. For example, the flow of capital services from a group of machines is measured as the services of the machines per period of time, and the stock of capital is measured as the number of machines. The flow of capital services reflects the own rate of return to capital and the rate of depreciation, both expressed per period of time, as well as the quantity of capital stock. The flow of services per unit of stock varies from one type of capital to another, so that the constants $\{Q_{Kj}\}$ can be taken as measures of the quality of capital stock in producing capital services.

The translog index of aggregate capital input can be expressed in terms of its components or in terms of capital stocks.

$$\begin{aligned} \ln K(T) - \ln K(T-1) &= \Sigma \bar{v}_j [\ln K_j(T) \\ &\quad - \ln K_j(T-1)], \\ &= \Sigma \bar{v}_j [\ln A_j(T-1) \\ &\quad - \ln A_j(T-2)]. \end{aligned}$$

If we define the stock of capital at the beginning of the preceding time period, say $A(T-1)$, as a translog index of its components,

$$\ln A(T-1) - \ln A(T-2) = \Sigma \bar{v}_{Aj} [\ln A_j(T-1) - \ln A_j(T-2)],$$

with weights given by the value shares of the individual capital stocks $\{v_{Aj}\}$ and

$$\bar{v}_{Aj} = \tfrac{1}{2}[v_{Aj}(T-1) + v_{Aj}(T-2)], \qquad (j = 1, 2, \ldots, n),$$

we can define an index of the quality of capital stock, say $Q_K(T)$, that transforms the translog index of capital stock into the translog index of capital input

$$K(T) = Q_K(T) A(T-1).$$

Our index of the quality of capital stock can be expressed in the form

$$\begin{aligned} \ln Q_K(T) - \ln Q_K(T-1) = \Sigma \bar{v}_j &[\ln A_j(T-1) \\ &- \ln A_j(T-2)] \\ &- [\ln A(T-1) \\ &- \ln A(T-2)], \end{aligned}$$

---

[4] The perpetual inventory method has been employed by Goldsmith [12] and in the BEA capital stock study [1]. The dual to the perpetual inventory method, involving investment goods prices and capital input prices, was introduced by Christensen and Jorgenson [3, 5]. For further discussion of the underlying model of durable capital goods, see [13].

so that this index reflects changes in the composition of capital. If all components of capital stock are growing at the same rate, quality remains unchanged. If components with higher flows of capital input per unit of stock are growing more rapidly, quality will increase. If components with lower flows per unit of stock are growing more rapidly, quality will decline.

Second, for each of the components of labor input $\{L_K(T)\}$ the flow of labor services is proportional to hours worked, say $\{H_K(T)\}$.

$$L_k(T) = Q_{Lk} H_k(T), \qquad (k = 1, 2, \ldots, p),$$

where the constants of proportionality $\{Q_{Lk}\}$ transform hours worked into a flow of labor services per period of time. The flow of services varies from one type of labor to another, so that the constants $\{Q_{Lk}\}$ can be taken as measures of the quality of hours worked in producing labor services.

The translog index of aggregate labor input can be expressed in terms of its components or in terms of hours worked

$$\begin{aligned} \ln L(T) - \ln L(T-1) &= \Sigma \bar{v}_k [\ln L_k(T) - \ln L_k(T-1)], \\ &= \Sigma \bar{v}_k [\ln H_k(T) - \ln H_k(T-1)]. \end{aligned}$$

If we define hours worked, say $H(T)$, as the unweighted sum of its components,

$$H(T) = \Sigma H_k(T),$$

we can define an index of the quality of hours worked, say $Q_L(T)$, that transforms hours worked into the translog index of labor input.

$$L(T) = Q_L(T) H(T).$$

Our index of the quality of hours worked can be expressed in the form

$$\begin{aligned} \ln Q_L(T) - \ln Q_L(T-1) &= \Sigma \bar{v}_k [\ln H_k(T) - \ln H_k(T-1)] \\ &\quad - [\ln H(T) - \ln H(T-1)], \end{aligned}$$

so that this index reflects changes in the composition of hours worked. Quality remains unchanged if all components of hours worked are growing at the same rate. Quality rises if components with higher flows of labor input per hour worked are growing more rapidly and falls if components with lower flows of input per hour worked are growing more rapidly.

We have decomposed the growth rate of the translog index of aggregate output into the sum of a weighted average of the growth rates of translog indexes of aggregate capital and labor input and the rate of technical change. Using the indexes of capital and labor quality, we can decompose the output growth rate as follows:

$$\begin{aligned} \ln Y(T) - \ln Y(T-1) &= \bar{v}_k [\ln K(T) - \ln K(T-1)] \\ &\quad + \bar{v}_L [\ln L(T) - \ln L(T-1)] \\ &\quad + \bar{v}_T \\ &= \bar{v}_K [\ln Q_K(T) - \ln Q_K(T-1)] \\ &\quad + \bar{v}_K [\ln A(T-1) - \ln A(T-2)] \\ &\quad + \bar{v}_L [\ln Q_L(T) - \ln Q_L(T-1)] \\ &\quad + \bar{v}_L [\ln H(T) - \ln H(T-1)] \\ &\quad + \bar{v}_T. \end{aligned}$$

The output growth rate is the sum of a weighted average of the growth rates of capital stock and hours worked, a weighted average of the growth rates of quality of capital stock and hours worked, and the rate of technical change.

Finally, we can define an index of real product per hour worked, say $M(T)$, that transforms hours worked into the index of real product

$$Y(T) = M(T) H(T).$$

Our index of real product per hour worked can be expressed in the form

$$\begin{aligned} \ln M(T) - \ln M(T-1) &= \bar{v}_K [\ln Q_K(T) - \ln Q_K(T-1)] \\ &\quad + \bar{v}_L [\ln Q_L(T) - \ln Q_L(T-1)] \\ &\quad + \bar{v}_K \left[\ln \frac{A(T-1)}{H(T)} - \ln \frac{A(T-2)}{H(T-1)}\right] + \bar{v}_T. \end{aligned}$$

The growth rate of real product per hour worked is the sum of a weighted average of the growth rates of quality of capital stock and hours worked with weights given by the value shares of capital and labor input, the growth rate of capital stock per hour worked weighted by the value share of capital input, and the growth rate of total factor productivity.

3. Production Account

Introduction

Our next objective is to identify output, capital input, labor input, and technical change with accounts for real product, real capital input, real labor input, and total factor productivity for each of the nine countries included in our study. It is important to emphasize that only the translog indexes of output, capital input, labor input, and technical change can be derived from the theoretical model of production we have presented in section 2. The stock of capital, the number of hours worked, the indexes of quality of capital stock and hours worked, and the index of output per hour worked are purely descriptive measures. In this section we outline the principles we have followed in constructing production accounts for the nine countries in our study. A description of the complete accounting system and details of its empirical implementation for the United States can be found in [5].[5]

Product and Factor Outlay

The starting point for constructing translog indexes of output and technical change is the measurement of the values in current prices of total product and total factor outlay. The fundamental accounting identity for the production account is that the value of total product equals the value of total factor outlay. We exclude indirect business taxes unrelated to factor outlay, such as retail sales taxes and excise taxes, from the value of total product; however, indirect business taxes that are part of the outlay on factor services, such as property taxes, are retained in the value of total factor outlay and total product. Our concept of output is intermediate between output at market prices and output at factor cost.

The production account in a complete system of national economic accounts includes the activities of the private sector, the government sector, and the rest of the world. In analyzing productive activity and its distribution between consumption and investment on the output side and between capital and labor on the input side, we have limited the scope of our production account to the private domestic sector of each country. Rest of the world production is excluded on the grounds that it can reflect a different physical and social environment for productive activity than the environment provided for the domestic sector.

The boundary between private and government activity varies from country to country within our study, due to variations in the role of government enterprises. Although government administration must be excluded from our private domestic production account, essentially similar economic activities — telecommunications, transportation, and public utilities — are conducted by government enterprises and by private enterprises. For some of the countries included in our study it is impossible to obtain separate accounts for government and private enterprises. For the United States, on the other hand, government enterprises are treated in a manner that is more closely analogous to the treatment of government administration than to the treatment of private enterprises. No separate capital accounts are maintained for government enterprises and government administration. Of course, government enterprises produce an almost negligible proportion of the gross national product of the United States. To provide international comparability in the scope of our product measure we have included government enterprise product for all countries.

The inclusion of government enterprises in gross private domestic product should not result in confusion, since "private" gross national product includes government enterprises in the official national income and product accounts of all nine countries. One unconventional aspect of our measure of total output is an imputation for the services of consumer durables. Our objective is to attain consistency in the treatment of owner-occupied residential structures and owner-utilized consumer durable equipment. It is standard procedure for national income accounts to include an imputation for owner-occupied housing in national product but not to include an analogous imputation for consumer durables. Our measure of total input is gross private domestic factor outlay, which is equal to gross private domestic product.

The product and factor outlay accounts are linked through capital formation and the compensation of property. To make this link explicit we divide total output between consumption and investment goods and total factor outlay between labor and property compensation. We include all services and nondurable goods in consumption goods; we include all structures and producer and consumer durable equipment in investment goods. Data for the United States are available for a complete separation of gross private domestic product between consumption goods and investment goods. For all nine countries it has been possible to separate gross private domestic product between consumption goods and investment goods, except for inventory investment and net exports. The value shares of investment goods product for each country are presented in Table 1.

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[5] A detailed description of sources and methods for each country is available in our report to the Office of International Competitiveness, U.S. Department of Commerce and the Bureau of International Labor Affairs, U.S. Department of Labor; see [4].

To divide total factor outlay between labor and property compensation it is necessary to allocate the factor outlay for self-employed persons between labor and property compensation. We have used Christensen's method [2] to impute labor compensation to self-employed workers; we have assigned the estimated wage rate for employees to the self-employed. Christensen has shown that for the United States this method results in an allocation consistent with the assumption that after-tax rates of return are equal in the corporate and noncorporate sectors. The value shares of property compensation for each country are presented in Table 2.

Real Capital Input

The starting point for the computation of a translog quantity index of capital input is a perpetual inventory estimate of the stock of each type of capital, based on past investments in constant prices. At each point in time the stock of each type of capital is the sum of past investments weighted by relative efficiency. Under the assumption that the efficiency of capital goods declines geometrically, the rate of replacement for the jth capital good, say δ_j, is a constant. Capital stock at the end of each period can be estimated from investment during the period and capital stock at the beginning of the period

$$A_j(T) = I_j(T) + (1-\delta_j)A_j(T-1),$$
$$(i = 1, 2, \ldots, n).$$

We have compiled time series of capital stock estimates for seven asset classes: consumer durables, nonresidential structures, producer durable equipment, residential structures, nonfarm inventories, farm inventories, and land. For each of the seven asset classes we derive perpetual inventory estimates of the stock as follows: First, we obtain a benchmark estimate of capital stock from data on national wealth in constant prices. Second, we deflate the investment series from the national income and product accounts to obtain investment in constant prices. Third, we choose an estimate of the rate of replacement from data on lifetimes of capital goods. Finally, we estimate capital

Table 1
Value Share of Investment Goods Product, 1947–73

Year	Canada	France	Germany	Italy	Japan	Korea	Netherlands	United Kingdom	United States
1947	.275								.279
1948	.294								.306
1949	.300								.287
1950	.307	.243	.304						.337
1951	.294	.255	.324				.251		.336
1952	.297	.249	.336	.247	.298		.243		.318
1953	.299	.242	.321	.252	.271		.272		.314
1954	.296	.249	.339	.258	.274		.279		.303
1955	.302	.262	.368	.266	.295		.297	.213	.334
1956	.327	.264	.362	.267	.334		.310	.216	.331
1957	.332	.272	.365	.277	.372		.322	.223	.323
1958	.313	.274	.359	.272	.322		.300	.227	.295
1959	.306	.272	.363	.278	.351		.316	.235	.315
1960	.297	.276	.386	.289	.389	.125	.325	.238	.297
1961	.292	.287	.391	.300	.450	.132	.326	.238	.291
1962	.300	.292	.396	.305	.414	.152	.326	.233	.302
1963	.309	.294	.390	.309	.421	.160	.319	.234	.306
1964	.313	.309	.414	.290	.429	.139	.342	.253	.306
1965	.326	.311	.422	.269	.408	.169	.341	.251	.314
1966	.336	.317	.398	.263	.414	.227	.340	.246	.313
1967	.329	.317	.358	.269	.443	.232	.343	.253	.301
1968	.330	.319	.389	.276	.458	.270	.348	.257	.303
1969	.324	.326	.412	.281	.463	.281	.334	.250	.300
1970	.324	.327	.424	.284	.482	.264	.349	.254	.288
1971	.321	.331	.420	.284	.469	.250	.347	.258	.293
1972	.323	.333	.409	.280	.460	.224	.333	.255	.300
1973	.323	.333	.405	.281	.486	.256	.329	.264	.302

Table 2
Value Share of Capital Input, 1947–73

Year	Canada	France	Germany	Italy	Japan	Korea	Netherlands	United Kingdom	United States
1947	.346								.370
1948	.376								.379
1949	.397								.375
1950	.413	.439	.340						.395
1951	.406	.387	.348				.474		.402
1952	.430	.376	.368	.419	.382		.480		.393
1953	.426	.396	.361	.420	.334		.467		.377
1954	.418	.386	.358	.394	.335		.469		.396
1955	.449	.381	.371	.403	.336		.483	.385	.399
1956	.443	.372	.369	.399	.351		.482	.370	.384
1957	.423	.377	.373	.400	.362		.468	.379	.381
1958	.441	.360	.369	.402	.346		.454	.381	.399
1959	.444	.366	.386	.407	.362		.459	.386	.394
1960	.444	.389	.396	.409	.391	.332	.465	.385	.396
1961	.447	.385	.389	.418	.433	.394	.448	.381	.402
1962	.448	.384	.379	.415	.401	.385	.443	.378	.406
1963	.460	.387	.385	.389	.398	.405	.437	.389	.409
1964	.470	.394	.395	.379	.422	.423	.432	.387	.411
1965	.467	.398	.400	.385	.402	.394	.432	.384	.422
1966	.462	.431	.400	.396	.415	.384	.416	.383	.424
1967	.440	.436	.405	.390	.431	.325	.424	.389	.416
1968	.442	.432	.423	.391	.442	.341	.433	.394	.410
1969	.436	.441	.421	.404	.441	.334	.422	.386	.407
1970	.434	.443	.413	.374	.436	.355	.413	.371	.391
1971	.441	.435	.405	.332	.409	.342	.415	.387	.400
1972	.430	.439	.409	.331	.405	.355	.421	.405	.410
1973	.470	.439	.404	.329	.396	.378	.410	.404	.415

stock in every period by applying the perpetual inventory method as outlined in section 2.

Each type of capital stock can be valued in current prices by using an index of the acquisition prices for new capital goods. We employ the investment goods price indexes to convert stocks of assets in constant prices to stocks of assets in current prices. These values can be employed in estimating value shares by class of assets. The value shares and stocks can be combined to obtain a translog quantity index of aggregate capital stock. The price index of capital stock is obtained by dividing the value of all assets by the translog quantity index. Value shares of the seven assets in each country for 1970 are presented in Table 3.

To construct translog price and quantity indexes of capital input we require value shares of individual capital inputs in total property compensation and stocks of individual assets. In the absence of taxation the value of the jth capital input is the sum of depreciation and the own return to capital, defined as the nominal return less revaluation.

$$\begin{aligned} p_{Kj}(T)\,K_j(T) = {} & [p_{Ij}(T-1)\,r(T) + p_{Ij}(T)\,\delta_j \\ & - (p_{Ij}(T) - p_{Ij}(T-1))]\,A_j(T-1), \\ & (j = 1, 2, \ldots, n). \end{aligned}$$

Given property compensation, the stock of assets, the price of acquisition of capital stock, and the rate of depreciation, we can determine the nominal rate of return. The nominal rate of return is equal to the ratio of property compensation less depreciation plus revaluation of assets to the value of capital stock at the beginning of the period.

In measuring the rate of return, differences in tax treatment of property compensation must be taken into account. For tax purposes the private domestic sector can be divided into corporate business, noncorporate business, and households and nonprofit institutions. Households and institutions are not subject to direct taxes on the flow of capital services they utilize. Noncorporate business is subject to personal income

Table 3
Value Shares of Capital Stock by Asset Class, 1970

	Canada	France	Germany	Italy	Japan	Korea	Netherlands	United Kingdom	United States
Consumer durables	.106	.067	.076	.081	.055	.038	.094	.086	.137
Nonresidential structures	.233	.150	.193	.180	.376	.239	.192	.205	.157
Producer durables	.156	.198	.222	.173		.176	.206	.316	.136
Residential structures	.200	.276	.294	.371	.188	.177	.253	.168	.216
Nonfarm inventories	.067	.111	.078	.077	.139	.110	.091	.105	.077
Farm inventories	.017					.043		.019	.012
Land	.222	.198	.136	.117	.243	.217	.163	.101	.263

taxes on income generated from capital services, and corporate business is subject to both corporate and personal income taxes. Households and corporate and noncorporate business are subject to indirect taxes on property income through taxes levied on the value of property. In order to take these differences into account we allocate each class of assets among the four sectors. For all countries, households and institutions have been treated separately from the business sector; for some of the countries it was not possible to separate the corporate and noncorporate sectors.

Property compensation associated with assets in the household sector is not taxed directly; however, part of the income is taxed indirectly through property taxes. To incorporate property taxes into our indexes of the price and quantity of capital services we add property taxes to the return to capital and depreciation in the definition of the value of the jth capital input.

$$\begin{aligned} p_{Kj}(T)\,K_j(T) = \; & \{p_{Ij}(T-1)\,r(T) + p_{Ij}(T)\,\delta_j \\ & - [p_{Ij}(T) - p_{Ij}(T-1)] \\ & + p_{Ij}(T)\,t_j(T)\}\,A_j(T-1), \\ & (j = 1, 2, \ldots, n), \end{aligned}$$

where t_j is the rate of property taxation. The nominal rate of return is the ratio of property compensation less depreciation plus revaluation of capital assets less property taxes to the value of capital stock at the beginning of the period.

Given the nominal rate of return for households and institutions, we can construct estimates of capital input prices for each class of assets held by households and institutions — land held by households and institutions, residential structures, nonresidential structures, producer durables, and consumer durables. These estimates require acquisition prices for each capital good, rates of replacement, rates of property taxation for assets held by households, and the nominal rate of return for the sector as a whole. We employ separate effective tax rates for owner-occupied residential property, both land and structures, and for consumer durables. Finally, we combine the price and quantity of capital input for each asset class into a translog index of capital input for households and institutions.

To obtain an estimate of the noncorporate rate of return we deduct property taxes from noncorporate property compensation, add revaluation of assets, subtract depreciation, and divide the result by the value of noncorporate assets at the beginning of the period. The noncorporate rate of return is gross of personal income taxes on noncorporate property compensation. Property compensation of households and institutions is not subject to the personal income tax. The value of property compensation in the noncorporate sector is equal to the value of the flow of capital services from residential and nonresidential structures, producer durable equipment, farm and nonfarm inventories, and land held by the sector. All farm inventories are assigned to the noncorporate sector. Given the noncorporate rate of return, estimated from noncorporate property compensation by the method outlined above, and given data on prices of acquisition, stocks, tax rates, and replacement rates for each asset class, we can estimate capital input prices for each asset class. Price and quantity data are combined into a translog index of the quantity of capital input for the noncorporate sector.

We next consider the measurement of prices and quantities of capital input for corporate business. To obtain an estimate of the corporate rate of return we must take into account the corporate income tax. For the United States, the value of capital input for the corporate sector, modified to incorporate the corporate income tax and indirect business taxes, becomes

$$p_{Kj}(T)K_j(T) = \left\{ \left[\frac{1-u(T)z_j(T)-k_j(T)+y_j(T)}{1-u(T)} \right] \right.$$

$$[p_{Ij}(T-1)r(T)+p_{Ij}(T)\delta_j-(p_{Ij}(T)$$

$$\left. -p_{Ij}(T-1))]+p_{Ij}(T)t_j(T) \right\} A_j(T-1),$$

$$(j=1,2,\ldots,n),$$

where $u(T)$ is the corporate tax rate, $z_j(T)$ is the present value of depreciation allowances on one dollar's investment, $k_j(T)$ is the investment tax credit, and $y_j(T) = k_j(T)u(T)z_j(T)$ for 1962 and 1963 and zero for all other years. The tax credit is different from zero only for producers' durables. Depreciation allowances are different from zero only for producers' durables and structures. For other countries this formula has been adapted in order to reflect the corporate tax structure in each country.

Our method for estimating the corporate nominal rate of return is the same as for the noncorporate nominal rate of return. Property compensation in the corporate sector is the sum of the value of services from residential and nonresidential structures, producer durable equipment, nonfarm inventories, and land held by that sector. To estimate the nominal rate of return in the corporate sector, we require estimates of the variables that describe the corporate tax structure — the effective corporate tax rate, the present value of depreciation allowances, and the investment tax credit. We obtain estimates of all the variables — acquisition prices and stocks of assets, rates of replacement, and variables describing the tax structure — that enter the value of capital input except, of course, for the nominal rate of return. We then determine the nominal rate of

Table 4
Own Rate of Return to Capital in the Business Sector, 1947–73

Year	Canada	France	Germany	Italy	Japan	Korea	Netherlands	United Kingdom	United States
1947	.057								.077
1948	.068								.079
1949	.072								.063
1950	.070	.093	.053						.065
1951	.058	.069	.065				.057		.071
1952	.073	.058	.071	.049	.044		.045		.059
1953	.066	.066	.065	.057	.030		.053		.052
1954	.053	.063	.067	.050	.037		.066		.052
1955	.066	.062	.082	.063	.048		.072	.071	.061
1956	.075	.059	.079	.063	.057		.067	.072	.049
1957	.059	.059	.079	.063	.056		.065	.071	.048
1958	.061	.050	.073	.068	.042		.056	.067	.049
1959	.060	.049	.079	.073	.052		.061	.072	.051
1960	.055	.064	.087	.078	.072	.066	.067	.081	.046
1961	.050	.061	.079	.088	.102	.109	.057	.081	.049
1962	.055	.062	.069	.086	.079	.095	.055	.073	.059
1963	.060	.061	.067	.075	.085	.173	.050	.081	.061
1964	.064	.066	.072	.062	.108	.217	.057	.089	.063
1965	.067	.066	.074	.067	.092	.157	.054	.085	.071
1966	.066	.081	.069	.077	.107	.156	.046	.078	.076
1967	.053	.081	.061	.080	.129	.103	.051	.079	.068
1968	.054	.081	.075	.080	.144	.113	.053	.081	.062
1969	.046	.088	.075	.092	.138	.124	.053	.069	.053
1970	.049	.085	.079	.074	.137	.131	.051	.057	.045
1971	.047	.080	.070	.046	.109	.124	.046	.065	.048
1972	.045	.083	.067	.042	.105	.141	.047	.066	.054
1973	.065	.083	.064	.035	.101	.185	.044	.058	.058

return from these variables and total corporate property compensation.

To estimate the nominal rate of return in the corporate sector, we first subtract property taxes from total property compensation before taxes, then subtract corporate profits tax liability. We then add revaluation of assets, subtract depreciation, and divide the result by the value of corporate assets at the beginning of the period. The corporate rate of return is gross of personal income taxes, but net of the corporate income tax. We estimate the price of capital input for each asset employed in the corporate sector by substituting the corporate rate of return into the corresponding formula for the price of capital input. These formulas also depend on acquisition prices of capital assets, rates of replacement, and variables describing the tax structure. Data on the stock of each asset class are constructed by the perpetual inventory method. Price and quantity data of capital input by asset class are combined into a translog index of the quantity of capital input for the corporate sector.

It is interesting to compare the rate of return on capital over time and across countries. In Table 4 we present own rates of return for the business sector. These rates of return are computed as a weighted average of own rates of return on corporate and noncorporate assets, using the value of assets at the beginning of the period in each sector as weights. Own rates of return are adjusted for differences in rates of inflation over time and across countries. Capital input prices depend only on own rates of return. The price and quantity index numbers for capital input in the various sectors can be combined into a price and quantity index for the private domestic sector. The quantity index is a translog index number and the price index is defined as the ratio of property compensation to the quantity index. Growth rates of real capital input are presented for each country in Table 5.

Real Product and Factor Input

To construct a quantity index of labor input it would be desirable to use the formula for a translog labor index for a large number of skill classifications. Classifications could be defined by level of education, sex, age, occupation, and so on. Following Jorgenson and Griliches [14], we have limited our consideration to a single skill measure — educational attainment. This results in a quality of labor index, which we apply to total

Table 5

Annual Rates of Growth of Real Private Domestic Capital Input 1947–73

Year	Canada	France	Germany	Italy	Japan	Korea	Netherlands	United Kingdom	United States
1948	.092								.067
1949	.072								.063
1950	.071								.042
1951	.083	.054	.043						.067
1952	.073	.042	.052				.026		.054
1953	.066	.039	.070	.019	.014		.004		.037
1954	.074	.044	.068	.027	−.003		.021		.039
1955	.049	.048	.075	.027	.016		.052		.032
1956	.064	.051	.088	.034	.017		.055	.053	.052
1957	.080	.055	.080	.038	.078		.064	.035	.042
1958	.065	.052	.077	.040	.119		.062	.040	.034
1959	.049	.045	.073	.037	.054		.035	.044	.018
1960	.048	.042	.069	.042	.069		.041	.051	.034
1961	.043	.054	.082	.055	.109	.008	.061	.056	.031
1962	.036	.059	.079	.066	.157	.012	.071	.049	.023
1963	.041	.064	.079	.070	.113	.037	.073	.039	.034
1964	.045	.066	.067	.078	.089	.059	.063	.046	.039
1965	.054	.070	.077	.049	.117	.050	.073	.060	.043
1966	.065	.061	.084	.036	.089	.038	.074	.051	.053
1967	.068	.064	.066	.039	.033	.096	.062	.041	.057
1968	.054	.060	.041	.052	.117	.111	.057	.043	.044
1969	.049	.059	.055	.049	.140	.124	.059	.045	.046
1970	.051	.067	.071	.053	.138	.133	.060	.034	.046
1971	.037	.064	.076	.060	.148	.107	.076	.035	.031
1972	.044	.062	.073	.049	.123	.101	.067	.047	.035
1973	.052	.064	.062	.046	.116	.069	.062	.059	.045

manhours in the private domestic sector. Growth rates of real labor input are presented for each country in Table 6. The quantity indexes of private domestic capital and labor input can be combined into a translog quantity index of private domestic factor input. The price index is then computed as the ratio of the value of private domestic input to the quantity index. Growth rates of real factor input are presented for each country in Table 7.

Given measures of total product in current prices, the remaining task is to separate these data into price and quantity components. Total product is first divided into investment goods and consumption goods. These components of total product are separated into price and quantity components using deflators from the national income and product accounts. The quantity indexes for consumption and investment goods are then combined using translog index numbers. Price indexes are constructed so that the product of price and quantity indexes equals the current dollar magnitude. Since inventory investment and net exports can be negative, quantity indexes are added to the quantity index of consumption and investment goods to obtain the quantity index of gross private domestic product. Growth rates of real product are presented for each country in Table 8. Growth rates of total factor productivity, where total factor productivity is defined as the ratio of real product to real factor input, are presented for each country in Table 9. Finally, growth rates of output per hour worked, where output per hour worked is defined as the ratio of real product to hours worked, are presented in Table 10.

4. International Comparisons

Introduction

Our international comparisons are based on growth of output, input, total factor productivity, and output per hour worked for the nine countries included in our study. In section 3 we have presented annual growth rates of real gross private domestic product, real gross private domestic factor input, total factor productivity, and output per hour worked for all nine countries.[6] We have also presented growth rates of real capital input and real labor input for these countries. In this section we first examine growth in real factor input and in total

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[6] All annual growth rates presented in this paper are computed as first differences of natural logarithms.

Table 6
Annual Rates of Growth of Real Private Domestic Labor Input, 1947–73

Year	Canada	France	Germany	Italy	Japan	Korea	Netherlands	United Kingdom	United States
1948	.013								.016
1949	.017								−.039
1950	−.019								.038
1951	.020	.016	.030						.044
1952	.011	−.006	.022				−.006		.010
1953	.014	−.007	.029	.031	.049		.024		.017
1954	−.005	.010	.035	.033	.027		.024		−.034
1955	.017	.003	.044	.004	.040		.023		.035
1956	.043	.005	.015	−.001	.077		.020	.005	.021
1957	.014	.010	−.014	.031	.049		.006	−.020	−.008
1958	−.015	−.007	−.009	.005	.035		−.006	−.012	−.027
1959	.031	−.006	−.006	.023	.046		.020	.024	.041
1960	.010	.015	.012	.051	.059		.025	.014	.013
1961	−.021	.004	−.000	.026	.013	.061	−.029	.022	−.005
1962	.029	.007	−.016	.003	.022	.019	.026	.002	.028
1963	.017	.008	−.016	.028	.026	.041	.021	.014	.016
1964	.031	.013	.012	−.036	.030	−.002	.013	.018	.021
1965	.032	−.006	−.008	−.075	.043	.106	.014	−.002	.037
1966	.027	.012	−.019	.027	.027	.030	.011	−.013	.038
1967	.019	−.002	−.058	.039	.038	.057	−.018	−.015	.015
1968	.002	−.007	.018	.021	.034	.079	.014	−.000	.024
1969	.019	.017	.016	−.006	.014	.063	.016	.005	.032
1970	−.001	.008	.006	.026	.018	.002	−.004	−.027	−.011
1971	.019	−.002	−.022	−.019	.012	.066	−.001	−.053	.006
1972	.027	−.003	−.016	−.016	.014	.064	−.018	.010	.038
1973	.054	.007	−.003	.007	.033	.066	−.004	.038	.050

Table 7

Annual Rates of Growth of Real Private Domestic Factor Input, 1947–73

Year	Canada	France	Germany	Italy	Japan	Korea	Netherlands	United Kingdom	United States
1948	.042								.036
1949	.038								.000
1950	.017								.039
1951	.046	.032	.034						.054
1952	.037	.012	.033				.009		.028
1953	.036	.011	.044	.026	.036		.015		.025
1954	.028	.023	.047	.030	.017		.023		−.005
1955	.031	.020	.055	.013	.032		.037		.034
1956	.052	.022	.042	.013	.056		.037	.023	.033
1957	.043	.027	.021	.034	.059		.034	.001	.011
1958	.020	.014	.023	.019	.064		.025	.007	−.002
1959	.039	.013	.024	.029	.048		.027	.032	.032
1960	.027	.025	.034	.047	.063		.032	.028	.022
1961	.007	.023	.032	.038	.052	.042	.012	.035	.010
1962	.032	.027	.021	.029	.078	.016	.046	.020	.026
1963	.028	.029	.020	.045	.061	.039	.044	.024	.023
1964	.038	.034	.034	.007	.054	.023	.035	.029	.028
1965	.042	.024	.026	−.027	.073	.083	.039	.022	.040
1966	.044	.033	.022	.030	.052	.033	.038	.011	.045
1967	.041	.027	−.008	.039	.057	.071	.015	.007	.033
1968	.025	.022	.028	.033	.071	.090	.032	.017	.033
1969	.032	.036	.033	.016	.070	.084	.034	.020	.038
1970	.022	.034	.033	.036	.071	.047	.023	−.004	.012
1971	.028	.027	.019	.009	.069	.080	.031	−.020	.016
1972	.035	.026	.020	.006	.059	.077	.017	.025	.037
1973	.053	.032	.024	.020	.066	.067	.024	.046	.048

factor productivity as sources of growth in real product. We then look at growth in the quality of capital stock, the quality of hours worked, capital stock per hour worked, and total factor productivity as sources of growth in real product per hour worked.

Since annual growth rates of real product, real capital input, real factor input, total factor productivity, and real product per hour worked are available for all nine countries included in our study for the period 1960–73, we can compare patterns of productivity growth across countries for this period. For all countries except Korea, annual growth rates are available for periods ending in 1960 and beginning at various points of time from 1947 to 1955, so that we can compare patterns of productivity growth between time periods for every country except Korea. Since the earlier periods vary in length from country to country, we do not attempt to make systematic comparisons of productivity growth patterns across countries for periods before 1960–73.

Aggregate Economic Growth

We present average annual growth rates for real product, real factor input, total factor productivity, real capital input, and real labor input in Table 11. This table provides average annual growth rates for all nine countries included in our study for the period 1960–73. Our first international comparisons of aggregate economic growth are based on growth in real product, real factor input, and total factor productivity for all nine countries for this period. Table 11 also includes average annual growth rates for all countries except Korea for earlier periods beginning from 1947 to 1955 and ending in 1960. Our intertemporal comparisons of growth patterns are based on data for the period 1960–73 and for the earlier periods.

During the 1960–73 period, average growth rates of real product fell within the relatively narrow range of 4.1 percent to 5.9 percent for six of the nine countries included in our study. For Canada and the United States, average growth rates of real product were 5.1 percent and 4.1 percent, respectively. For France, Germany, Italy, and the Netherlands, average growth rates were 5.9 percent, 5.4 percent, 4.8 percent, and 5.6 percent. Growth of real product for the United Kingdom fell below this range with an average rate of 3.8 percent. For Japan and Korea, growth of real product greatly exceeded this range with average rates of 10.9 percent and 9.8 percent, respectively.

Table 8

Annual Rates of Growth of Real Gross Private Domestic Product, 1947–73

Year	Canada	France	Germany	Italy	Japan	Korea	Netherlands	United Kingdom	United States
1948	.035								.055
1949	.054								.008
1950	.097								.093
1951	.039	.025	.099						.065
1952	.090	.031	.082				.015		.037
1953	.059	.080	.085	.087	.095		.075		.045
1954	−.006	.050	.079	.036	.064		.069		−.010
1955	.087	.053	.121	.082	.103		.072		.071
1956	.095	.046	.081	.047	.043		.054	.023	.023
1957	.027	.058	.066	.045	.097		.036	.026	.016
1958	.025	.015	.041	.056	.069		−.053	.010	.002
1959	.042	.050	.076	.065	.069		.100	.046	.058
1960	.029	.084	.095	.064	.112		.080	.061	.022
1961	.015	.053	.055	.084	.178	.053	.035	.050	.023
1962	.060	.063	.040	.060	.106	.026	.045	.015	.056
1963	.055	.058	.041	.047	.109	.099	.033	.039	.038
1964	.069	.076	.072	.034	.119	.071	.096	.072	.053
1965	.071	.054	.063	.034	.095	.071	.062	.025	.060
1966	.066	.058	.035	.056	.076	.120	.035	.028	.059
1967	.029	.050	.000	.073	.114	.083	.049	.031	.027
1968	.053	.044	.078	.055	.125	.121	.071	.039	.045
1969	.043	.081	.070	.061	.113	.176	.067	.010	.030
1970	.038	.061	.071	.053	.123	.077	.067	.037	−.000
1971	.050	.047	.031	−.026	.093	.089	.052	.034	.035
1972	.050	.054	.044	.028	.084	.094	.062	.051	.061
1973	.066	.067	.060	.061	.081	.199	.050	.068	.061

Among the six countries characterized by moderate growth of real product, the range of variation in average growth rates of real factor input is even narrower than for real product. For France, Germany, Italy, and the Netherlands the average growth rates of real factor input are 2.9 percent, 2.4 percent, 2.2 percent, and 3.0 percent, respectively, for the period 1960–73. For this period the average growth rate of real factor input for Canada is 3.3 percent and for the United States is 2.9 percent. By contrast the high growth countries, Japan and Korea, had the highest average growth rates of real factor input, 6.4 percent and 5.8 percent, respectively. The low growth country, the United Kingdom, had the lowest average growth rate in real factor input at 1.8 percent.

Our first conclusion is that variations in average growth rates of real product among countries during 1960–73 are associated with variations in growth rates of real factor input. This conclusion is based on all possible comparisons between growth rates of real product and real factor input for pairs of countries. For twenty-eight of the thirty-six possible comparisons the differences of growth rates of real product have the same sign as the differences of growth of real factor input. For example, a comparison of patterns of economic growth for 1960–73 for Italy and the United Kingdom reveals average growth rates of real product of 4.8 percent and 3.8 percent, respectively. These growth rates are associated with average growth rates of real factor input of 2.2 percent and 1.8 percent.

If we compare patterns of aggregate economic growth between the 1960–73 period and earlier periods for each country included in our study (except Korea), we find that average growth rates of real product have increased for France, Japan, the Netherlands, the United Kingdom, and the United States, and that average growth rates have decreased for Canada, Germany, and Italy. For every country with an increased average growth rate of real product, the average growth rate of real factor input has also increased or remained the same. The most dramatic increases are for Japan, where the average growth rate of real product rose from 8.1 percent for 1952–60 to 10.9 percent for 1960–73; the average growth rate of real factor input rose from 4.7 percent for the earlier period to 6.4 percent for the later period. At the opposite end of the spectrum, the

Table 9

Annual Rate of Growth of Total Factor Productivity

Year	Canada	France	Germany	Italy	Japan	Korea	Netherlands	United Kingdom	United States
1948	−.007								.019
1949	.016								.008
1950	.080								.054
1951	−.007	−.006	.064						.011
1952	.053	.019	.050				.005		.009
1953	.023	.069	.041	.062	.058		.061		.021
1954	−.034	.027	.032	.006	.047		.046		−.004
1955	.056	.033	.066	.069	.071		.034		.037
1956	.043	.024	.038	.034	−.014		.017	−.001	−.010
1957	−.016	.031	.045	.012	.038		.002	.025	.004
1958	.005	.001	.018	.037	.004		−.079	.002	.004
1959	.003	.037	.052	.036	.020		.073	.014	.026
1960	.003	.059	.061	.017	.049		.047	.033	.000
1961	.008	.030	.023	.046	.125	.011	.022	.015	.014
1962	.028	.036	.020	.031	.028	.009	−.002	−.005	.030
1963	.027	.029	.021	.002	.048	.060	−.011	.015	.015
1964	.032	.043	.038	.026	.065	.048	.061	.043	.025
1965	.029	.030	.037	.061	.022	−.012	.022	.003	.020
1966	.022	.025	.013	.025	.024	.087	−.003	.016	.014
1967	−.012	.023	.008	.034	.057	.012	.034	.025	−.006
1968	.029	.021	.051	.022	.054	.031	.038	.023	.013
1969	.010	.045	.038	.045	.043	.092	.033	−.010	−.008
1970	.016	.027	.038	.016	.053	.030	.044	.041	−.012
1971	.023	.019	.013	−.035	.024	.009	.021	.055	.019
1972	.016	.029	.024	.022	.025	.017	.045	.026	.024
1973	.013	.035	.037	.041	.015	.132	.027	.022	.013

growth rate of real product for the United Kingdom rose modestly from 3.3 percent for 1955–60 to 3.8 percent for 1960–73, and the growth rate of real factor input remained virtually unchanged at 1.8 percent for both periods.

Among countries with decreases in the average growth rate of real product, the greatest change was for Germany with a decline from 8.2 percent for 1950–60 to 5.4 percent during 1960–73. The average growth rate of real factor input dropped from 3.6 percent to 2.4 percent between the two periods. For Canada the growth rate of real product dropped from 5.2 percent for 1947–60 to 5.1 percent for 1960–73, and the growth rate of real factor input dropped from 3.5 percent to 3.3 percent between the two periods. For Italy the average growth rate of real product declined from 6.0 percent for 1952–60 to 4.8 percent for 1960–73, and the growth rate of real factor input declined from 2.6 percent for the earlier period to 2.2 percent for the later period. Our second conclusion is that increases and decreases in average growth rates of real factor input between 1960–73 and various earlier periods beginning from 1947 to 1955 and ending in 1960 are strongly associated with increases and decreases in average growth rates of real product for all eight countries for which data are available.

The most striking illustration of the association of growth in real factor input and growth in real product is provided by a comparison of patterns of aggregate economic growth for Germany and Japan. During 1950–60 Germany had an average growth rate of real product of 8.2 percent, and for 1952–60 Japan had an average growth rate of real product of 8.1 percent. For 1960–73 Japan's average growth rate of real product rose to 10.9 percent, and Germany's average growth rate fell to 5.4 percent. Japan's average growth rate of real factor input rose from 4.7 percent for the earlier period to 6.4 percent for the 1960–73 period, and Germany's average growth rate fell from 3.6 percent to 2.4 percent.

Growth in Capital and Labor Input

In analyzing the growth of real factor input among countries or between time periods for a given country, we first recall that the growth rate of real factor input is a weighted average of growth rates of real capital input

Table 10
Annual Rates of Growth of Output per Hour Worked

Year	Canada	France	Germany	Italy	Japan	Korea	Netherlands	United Kingdom	United States
1948	.025								.046
1949	.042								.052
1950	.121								.062
1951	.024	.014	.070						.026
1952	.085	.042	.061				.026		.033
1953	.051	.092	.057	.059	.045		.057		.034
1954	.005	.046	.045	.006	.045		.050		.029
1955	.076	.055	.078	.081	.051		.053		.042
1956	.059	.046	.066	.051	−.030		.038	.023	.008
1957	.019	.053	.081	.017	.050		.035	.051	.029
1958	.046	.028	.050	.054	.033		−.042	.028	.040
1959	.018	.061	.083	.044	.030		.085	.028	.029
1960	.026	.075	.084	.016	.058		.060	.053	.016
1961	.042	.055	.056	.069	.166	.004	.068	.034	.035
1962	.036	.061	.057	.069	.084	.019	.024	.019	.036
1963	.042	.055	.058	.031	.087	.071	.017	.031	.029
1964	.043	.068	.061	.083	.095	.085	.088	.060	.039
1965	.044	.064	.072	.122	.057	−.023	.053	.033	.030
1966	.044	.049	.055	.042	.051	.102	.029	.047	.029
1967	.015	.056	.060	.047	.083	.038	.073	.052	.021
1968	.057	.055	.061	.046	.098	.054	.062	.045	.030
1969	.028	.068	.055	.080	.111	.125	.056	.011	.006
1970	.043	.058	.066	.040	.114	.086	.076	.070	.019
1971	.036	.053	.054	.006	.088	.035	.058	.094	.038
1972	.028	.062	.061	.057	.076	.042	.086	.047	.032
1973	.017	.064	.065	.067	.056	.144	.059	.036	.020

Table 11
Average Annual Growth Rates of Real Product, Real Factor Input, Total Factor Productivity, Real Capital Input, and Real Labor Input

	Canada	France	Germany	Italy	Japan	Korea	Netherlands	United Kingdom	United States
					1960–73				
Real product	.051	.059	.054	.048	.109	.098	.056	.038	.041
Real factor input	.033	.029	.024	.022	.064	.058	.030	.018	.029
Total factor productivity	.018	.030	.030	.026	.045	.040	.026	.021	.011
Real capital input	.049	.063	.070	.054	.115	.073	.066	.046	.040
Real labor input	.020	.004	−.007	.002	.027	.050	.003	.000	.022
	1947–60	1950–60	1950–60	1952–60	1952–60		1951–60	1955–60	1947–60
Real product	.052	.049	.082	.060	.081		.050	.033	.036
Real factor input	.035	.020	.036	.026	.047		.027	.018	.025
Total factor productivity	.017	.029	.047	.034	.034		.023	.015	.011
Real capital input	.068	.047	.069	.033	.045		.040	.045	.046
Real labor input	.011	.003	.016	.022	.048		.014	.002	.012

and real labor input with weights given by the value shares of each input. We give value shares for capital input together with ratios of the average weighted growth rates of capital input, labor input, and total factor productivity to the average growth rate of real product in Table 12. The growth rate of each input is weighted by the value share of that input. Table 12 provides data for all nine countries for 1960–73 and for all countries except Korea for earlier periods ending in 1960.

Value shares for capital input vary within a narrow range from 0.369 for Korea to 0.449 for Canada for 1960–73, so that variations in weights assigned to capital and labor input account for little variation in average growth rates of real factor input across countries. However, average growth rates of real capital and labor input vary substantially among countries, as indicated in Table 11. For the European countries the growth rate of labor input ranges from a negative 0.7 percent for Germany to a positive 0.4 percent for France. Average growth rates of labor input for Canada and the United States are 2.0 percent and 2.2 percent, respectively, and for Japan and Korea are 2.7 percent and 5.0 percent, respectively.

Comparing average growth rates of real capital input among countries for 1960–73, we find that Japan and Korea have the highest average growth rates, with 11.5 percent and 7.3 percent, respectively. Canada, the United Kingdom, and the United States have relatively low average growth rates of 4.9 percent, 4.6 percent, and 4.0 percent. For the remaining European countries the average growth rates of capital input are higher than for the United Kingdom and the two North American countries and lower than for the two Asian countries. Average rates of growth for France, Germany, Italy, and the Netherlands are 6.3 percent, 7.0 percent, 5.4 percent, and 6.6 percent.

Our third conclusion is that for 1960–73 very high average growth rates in real product are associated with high average growth rates of both capital and labor input and that low average rates of growth in real product are associated with low average growth rates of both inputs. Average growth rates of real product in the moderate range from 4.5 to 6 percent, which includes five of the nine countries in our study, can be associated either with low average growth rates for labor and high growth rates for capital, as in Germany, or with high average growth rates for labor and low growth rates for capital, as in the United States. Since there are substantial variations among countries in average growth rates of both capital and labor input, further analysis requires a study of the sources of growth of capital input through the supply of saving and capital formation and the sources of growth of labor input through the supply of work effort.

We find it useful to illustrate our third conclusion by comparing the economic performance of the United Kingdom and the United States for 1960–73. The

Table 12

Value Share of Capital Input and Contributions of Growth in Real Capital Input, Real Labor Input and Total Factor Productivity to Growth in Real Product

	Canada	France	Germany	Italy	Japan	Korea	Netherlands	United Kingdom	United States
					1960–73				
Capital value share	.449	.417	.401	.383	.415	.369	.429	.387	.408
Contributions of									
Real capital input	.430	.444	.520	.435	.437	.264	.509	.468	.401
Real labor input	.209	.043	–.074	.020	.147	.324	.031	–.006	.317
Total factor productivity	.361	.513	.556	.545	.414	.412	.460	.538	.282
	1947–60	1950–60	1950–60	1952–60	1952–60		1951–60	1955–60	1947–60
Capital value share	.420	.382	.367	.405	.352		.470	.380	.387
Contributions of									
Real capital input	.549	.365	.310	.220	.197		.381	.513	.497
Real labor input	.127	.039	.120	.215	.380		.155	.042	.204
Total factor productivity	.325	.595	.568	.565	.421		.465	.445	.303

United States' average growth rate of real product is higher at 4.1 percent than the United Kingdom's at 3.8 percent. Average growth rates of real factor input are 2.9 percent for the United States and 1.8 percent for the United Kingdom. The difference in growth rates of real factor input can be accounted for by the difference in average rates of growth of real labor input, 0 for the United Kingdom and 2.2 percent for the United States. The United Kingdom's average growth rate of capital input of 4.6 percent exceeded that for the United States of 4.0 percent. The United Kingdom's average growth rate of total factor productivity of 2.1 percent also exceeded that for the United States of 1.1 percent. The difference in average growth rates of real labor input in the two countries accounts almost entirely for the difference in average growth rates of real product.

If we compare the growth of real factor input during 1960–73 with that of earlier periods, we first observe that the greatest change in value shares of capital input is Japan's increase to 0.415 for the period 1960–73 from 0.352 for the earlier period. Changes in value shares of capital input between time periods do not account for much variation in average growth rates of real factor input between time periods. For five of the eight countries included in our intertemporal comparisons, the value share of capital input increases between the earlier periods and the period 1960–73. If technical change were Hicks-neutral, this would imply an average elasticity of substitution in excess of unity for these five countries, since the growth rate of capital input exceeds the growth rate of labor input for all countries and all periods except Japan for the period 1952–60.

Comparing the average growth rates of real capital input and real labor input between time periods for Japan, we find that its average growth rate of real labor input for the period 1952–60 was 4.8 percent, and its average growth rate of real capital input was only 4.5 percent for this period. For the period 1960–73 Japan's average growth rate of labor input declined to 2.7 percent, still high by international standards, and its average growth rate of capital input jumped to 11.5 percent. The improvement in Japan's economic performance was due almost entirely to the increased average growth rate of real capital input.

Germany's decline in the average growth rate of real labor input from 1.6 percent during the period 1950–60 to −0.7 percent from 1960–73 was as large as Japan's decline from the period 1952–60 to the later period. Germany's average growth rate of capital input rose from 6.9 percent for 1950–60 to 7.0 percent for 1960–73 and its average growth rate of real product fell from 8.2 percent in the earlier period to 5.4 percent in the later period. The decline in Germany's economic performance was due primarily to the decreased average growth rate of real labor input; the contrast to changes in Japan's economic performance between 1960–73 and the earlier period is due to differences in the increase of the average growth rate of capital input.

Our fourth conclusion is that a rise or fall in the average growth rate of real labor input is associated with a fall or rise in the growth rate of real capital input. This pattern reflects the process of substitution between capital and labor input in production. Germany and Japan provide the most striking illustrations of this pattern with substantial changes in aggregate economic growth between 1960–73 and the earlier periods. However, the same pattern can be seen for two countries with moderate changes in aggregate economic growth — Canada and the United States. Canada's average growth rate of real capital input fell from 6.8 percent to 4.9 percent, and that for the United States fell from 4.6 percent to 4.0 percent, between the periods 1947–60 and 1960–73. For the same two periods, Canada's average growth rates of labor input rose from 1.1 percent to 2.0 percent, and the United States' rose from 1.2 percent to 2.2 percent. France is the only exception to the general pattern; its average growth rates of real labor input and real capital input rose from 0.3 percent to 0.4 percent and from 4.7 percent to 6.3 percent between the periods 1950–60 and 1960–73.

As a second illustration of our fourth conclusion we compare Korean growth for the period 1960–73 with Japanese growth for the period 1952–60. Japan's average growth rate of real labor input was 4.8 percent and Korea's was 5.0 percent. Korea's average growth rate of capital input was 7.3 percent, and Japan's was only 4.5 percent. Korea's average growth rate of real product for the later period was 9.8 percent, compared with Japan's rate of 8.1 percent for the earlier period. Korea's average growth rate of total factor productivity for the later period was 4.0 percent, and Japan's average in the earlier period was 3.4 percent. The difference in average growth rates of capital input accounts for the difference in economic performance.

Productivity Growth

Up to this point we have compared patterns of aggregate economic growth among the nine countries included in our study for the period 1960–73. We have also compared patterns of growth between various time periods beginning from 1947 to 1955 and extending to 1960 and the time period 1960–73 for all countries except Korea. We can provide additional perspective on these results by comparing patterns of growth in output per hour worked among countries and between time periods. In Table 13 we present average annual growth rates of real product per hour worked, real factor input

Table 13

Average Annual Growth Rates of Real Product per Hour Worked, Real Factor Input per Hour Worked, Capital Stock per Hour Worked, Quality of Capital Stock, Quality of Hours Worked

	Canada	France	Germany	Italy	Japan	Korea	Netherlands	United Kingdom	United States
					1960–73				
Real product per hour worked	.037	.059	.062	.058	.087	.060	.058	.045	.027
Real factor input per hour worked	.018	.028	.033	.033	.041	.021	.033	.025	.016
Capital stock per hour worked	.023	.051	.076	.061	.064	.020	.048	.048	.017
Quality of capital stock	.011	.012	.005	.004	.030	.014	.020	.004	.010
Quality of hours worked	.005	.004	.001	.013	.006	.012	.005	.006	.008
	1947–60	1950–60	1950–60	1952–60	1952–60		1951–60	1955–60	1947–60
Real product per hour worked	.046	.051	.067	.041	.035		.040	.037	.031
Real factor input per hour worked	.029	.021	.022	.007	.001		.017	.023	.020
Capital stock per hour worked	.045	.040	.059	.012	−.013		.022	.039	.031
Quality of capital stock	.017	.009	−.000	.002	.013		.009	.010	.010
Quality of hours worked	.006	.005	.001	.002	.002		.005	.006	.007

per hour worked, capital stock per hour worked, quality of capital stock, and quality of hours worked for all nine countries for the period 1960–73. Table 13 also includes average annual growth rates for earlier periods for all countries except Korea.

During the 1960–73 period, the range of variation in average growth rates of real product per hour worked is only slightly narrower than for real product itself. For Canada and the United States, the average growth rates are 3.6 percent and 2.7 percent. For France, Italy, the Netherlands, and the United Kingdom the average growth rates are 5.9 percent, 5.8 percent, 5.8 percent, and 4.5 percent, respectively. Germany's 6.2 percent growth of real product per hour worked is higher than Korea's 6.0 percent. Japan's 8.7 percent average growth rate of real product per hour worked is highest.

The range of variation of growth rates of real factor input per hour worked is narrower than that of growth rates of real product per hour worked, just as the range of variation of growth rates of real factor input is narrower than that of growth rates of real product. Average annual growth rates of real factor input per hour worked for Canada and the United States are 1.8 and 1.6 percent. For the four European countries characterized by moderate growth of real product per hour worked — France, Italy, the Netherlands, and the United Kingdom — the average growth rates of real factor input per hour worked are 2.8 percent, 3.3 percent, 3.3 percent, and 2.5 percent, respectively. Germany's 3.3 percent growth rate of real factor input per hour worked is above Korea's rate of 2.1 percent. Japan has the highest average growth rate of real factor input per hour worked at 4.1 percent as well as the highest average growth rate of real product per hour worked.

Our fifth conclusion is that variations in average growth rates of real product per hour worked among countries during the period 1960–73 are associated with variations in growth rates of real factor input per hour worked. This association is similar but not identical to the association we have found between growth rates of real product and real factor input during this period. For twenty-nine of thirty-six possible comparisons between pairs of countries the differences of growth rates of real product per hour worked have the same sign as differences of growth rates of real factor input per hour worked. For example, a comparison of patterns of productivity growth for the period 1960–73 for Italy and the United Kingdom shows average growth rates of real product per hour worked of 5.8 percent and 4.5 percent, respectively. These growth rates are associated with growth rates of real factor input per hour worked of 3.3 percent and 2.5 percent.

If we compare patterns of productivity growth between the period 1960–73 and earlier periods for each country included in our study, except Korea, we find that average growth rates of real product per hour worked have increased for France, Italy, Japan, the Netherlands, and the United Kingdom, and have decreased for Canada, Germany, and the United States. Every country with an increased average growth rate of real product per hour worked also has an increased average growth rate of real factor input per hour worked. The most dramatic increases are for Japan, where the average growth rate of real product per hour worked rose from 3.5 percent for the period 1952–60, the lowest for any country included in our study for periods before 1960, to 8.7 percent for the period 1960–73, the highest for any country included in our study for this period. Similarly, the growth rate of real factor input per hour worked rose from 0.1 percent for the earlier period to 4.1 percent for the later period, again the lowest and highest average growth rates for the two periods.

Among countries with decreases in the average growth rate of real product per hour worked, Canada's declined from 4.6 percent for the period 1947–60 to 3.6 percent for the period 1960–73. For the United States the decline was from 3.1 percent to 2.7 percent for these two periods. The corresponding declines in average growth rates of real factor input per hour worked were from 2.9 percent to 1.8 percent for Canada and from 2.0 percent to 1.6 percent for the United States. Germany's average growth rate of real product per hour worked fell from 6.7 percent for the period 1950–60 to 6.2 percent for the period 1960–73; its average growth rate of real factor input per hour worked rose from 2.2 percent to 3.3 percent for the same periods. Our sixth conclusion is that changes in growth rates of real product per hour worked and real factor input per hour worked between various earlier periods ending in 1960 and the period 1960–73 are almost as closely associated as changes in growth rates of real product and real factor input for the two periods.

A useful illustration of the association of growth in real factor input per hour worked and growth in real product per hour worked is provided by a comparison of patterns of productivity growth for the United Kingdom and the United States. During the period 1955–60 the United Kingdom's 3.7 percent average growth rate of real product per hour worked was higher than the United States' 3.1 percent for the period 1947–60. For the period 1960–73 the United Kingdom's growth rate of real product per hour worked rose to 4.5 percent, and that for the United States fell to 2.7 percent. For the period 1955–60 the United Kingdom's growth rate of real factor input per hour worked was 2.3 percent, and that for the United States for the period 1947–60 was 2.0 percent. For the period 1960–73 the growth rate of real factor input per hour worked for the United Kingdom rose to 2.5 percent, and that for the United States fell to 1.6 percent.

Real Factor Input Per Hour Worked

The growth rate in real factor input per hour worked is the sum of the growth rate of capital stock per hour worked, weighted by the value share of capital input, and a weighted average of growth rates of quality of capital stock and quality of hours worked, weighted by the value shares of capital and labor input, respectively. We give the ratios of the weighted growth rates of capital stock per hour worked, quality of capital stock, and quality of hours worked, and the unweighted growth rate of total factor productivity to the growth rate of real product per hour worked in Table 14. This table provides data for all nine countries included in our study for the period 1960–73 and for all countries except Korea for earlier periods ending in 1960.

Average growth rates of quality change for both capital and labor input are positive for all countries and for all time periods included in our study, except growth of capital quality for Germany for the period 1950–60. The average growth rate of capital stock per hour worked is positive for every country and every time period, except for Japan for the period 1952–60. Japan's growth rate of hours worked actually exceeded the growth rate of capital stock for the period 1952–60. For the period 1960–73 the contribution of capital stock per hour worked exceeds that of either quality of capital stock or quality of hours worked for all countries except Korea. For earlier periods, the contribution of capital stock per hour worked is greater for every country except Japan.

In accounting for growth in real product per hour worked for Canada, France, and Korea for the period 1960–73, growth in total factor productivity is more important than growth in quality of capital stock, hours worked, or capital stock per hour worked. Since these three countries are associated with low, moderate, and high growth rates of output per hour worked, respectively, there is no association between average growth rates of output per hour worked and a large contribution of total factor productivity for this period. For earlier periods the contribution of total factor productivity is more important than the contribution of other sources of growth in real product per hour worked for all countries except the United Kingdom and the

Table 14

Contributions of Growth in Capital Stock per Hour Worked, Quality of Capital Stock, Quality of Hours Worked, and Total Factor Productivity

	Canada	France	Germany	Italy	Japan	Korea	Netherlands	United Kingdom	United States
	1960–73								
Contributions of									
Capital stock per hour worked	.287	.360	.476	.397	.301	.125	.358	.417	.251
Quality of capital stock	.134	.084	.029	.027	.141	.086	.148	.039	.147
Quality of hours worked	.074	.042	.010	.135	.038	.126	.050	.082	.180
Total factor productivity	.506	.513	.487	.444	.516	.673	.445	.463	.423
	1947–60	1950–60	1950–60	1952–60	1952–60		1951–60	1955–60	1947–60
Contributions of									
Capital stock per hour worked	.415	.298	.299	.114	−.129		.254	.401	.391
Quality of capital stock	.155	.067	−.002	.019	.124		.105	.099	.123
Quality of hours worked	.071	.062	.007	.036	.030		.066	.101	.143
Total factor productivity	.366	.573	.693	.833	.968		.575	.400	.348

United States. Japan's average growth rate of total factor productivity for the period 1952–60 is almost equal to the average growth rate of real product per hour worked; the contribution of growth in total factor productivity, as we have defined it, is equal to 0.968.

Our seventh conclusion is that the contribution of growth in real factor input per hour worked is more important than the contribution of total factor productivity in accounting for growth in real product per hour worked for the period 1960–73 and less important for earlier periods beginning from 1947 to 1955 and ending in 1960. The most dramatic illustration of this conclusion is for Italy. During the period 1952–60 the contribution of real factor input per hour worked was 0.169, the lowest for any country and any time period included in our study (except Japan for the period 1952–60). For the period 1960–73 the contribution of real factor input per hour worked was 0.559, which exceeded the corresponding level for every other country except the United States. The United States' contribution of real factor input per hour worked fell from 0.657 for the period 1947–60 to 0.578 for the period 1960–73.

We find that the contributions of growth of the quality of capital stock and growth of the quality of hours worked are closely comparable for the period 1960–73. The contribution of growth in capital quality exceeds that of labor quality for Canada, France, Germany, Japan, and the Netherlands, but the contribution of growth in labor quality is larger for Italy, Korea, the United Kingdom, and the United States. For earlier periods the contribution of growth in capital quality is larger for Canada, France, Japan, and the Netherlands, but that of labor quality is larger for Germany, Italy, the United Kingdom and the United States. Our eighth and final conclusion is that the most important contribution to growth in real product per hour worked is provided by growth in capital stock per hour worked. Less significant contributions to growth in real product per hour worked are accountable to growth in capital and labor quality. Though of comparable magnitude, the former is somewhat more important.

A useful illustration of our final conclusion is provided by comparing contributions to growth in real product per hour worked for the United Kingdom and the United States. For the period 1960–73 the United Kingdom's average growth rate of real product per hour worked is 4.5 percent and the United States' is 2.7 percent. Growth rates of capital and labor quality are 0.4 and 0.6 percent, respectively, for the United Kingdom and 1.0 and 0.8 percent, respectively, for the United States. The differences in growth rates of real product per hour worked are largely attributable to the difference in growth rates of capital stock per hour worked, which was 4.8 percent for the United Kingdom and 1.7 percent for the United States. If we extend our comparison to earlier periods, we find that the United States' growth rate of capital stock per hour worked dropped from 3.1 percent for the period 1947–60 to 1.7 percent for the period 1960–73, and the United Kingdom's growth rate rose from 3.9 percent for the period 1955–60 to 4.8 percent for the period 1960–73. Growth rates of capital and labor quality are roughly similar between the two periods for each country. We conclude that the differences in growth of real product per hour worked between the United States and the United Kingdom and between the period 1960–73 and earlier periods for each country can be explained by differences in growth of capital stock per hour worked.

5. Summary

In section 2 we outlined a methodology for separating growth in real factor input from growth in total factor productivity, based on the transcendental logarithmic production function. Beginning with a production function that gives output as a function of capital input, labor input, and time, we defined translog indexes of output, capital input, labor input, and technical change in terms of data on prices and quantities of output and inputs at discrete points of time. We also introduced descriptive measures of the quality of capital stock and hours worked that transform indexes of capital stock and hours worked into translog indexes of capital and labor input. These descriptive measures are useful in comparing the results of our analysis of growth in total factor productivity with an analysis of growth in output per hour worked as a measure of productivity change.

In section 3 we identified translog indexes of output, capital input, labor input, and technical change with accounts for real product, real capital input, real labor input, and total factor productivity for each of the nine countries included in our study. For all countries we constructed annual production accounts in current and constant prices for the period 1960–73. For all countries except Korea we constructed annual production accounts for various earlier periods, beginning from 1947 to 1955 and ending in 1960.

Our first objective was to assess the relative importance of growth in real factor input and in total factor productivity in accounting for patterns of productivity growth for all nine countries for the period 1960–73 and for changes in productivity growth between earlier periods ending in 1960 and the period 1960–73 for all countries except Korea. We conclude that, for the nine countries included in our study, variations in aggregate economic growth for the period 1960–73 are associated with variations in the growth of real factor input. This conclusion is strongly reinforced by a comparison of patterns of aggregate economic growth for this period with growth during earlier periods ending in 1960 for each country except Korea.

Our second objective was to assess the relative importance of growth in real factor input per hour worked and in total factor productivity in accounting for the growth of output per hour worked. We find that variations in average growth rates of real product per hour worked for the period 1960–73 are associated with variations in growth rates of real factor input per hour worked. Changes in growth rates of real product per hour worked and real factor input per hour worked between earlier periods ending in 1960 and the period 1960–73 are also closely associated.

The third objective of our analysis was to assess the role of growth in real capital input and in real labor input in accounting for aggregate economic growth. For the period 1960–73 we find that very rapid growth of real product is associated with rapid growth of both real capital input and real labor input and that slow growth of real product is associated with slow growth of both inputs. Moderate growth of real product can be associated with rapid growth of real capital input, rapid growth of real labor input, or moderate growth rates of both inputs. Our intertemporal comparisons show that increases and decreases in the average growth rate of real capital input are associated with decreases and increases, respectively, in the average growth rate of real labor input. This finding provides evidence of substitution between capital and labor inputs in production.

Our fourth objective was to assess the role of growth in quality of capital stock, quality of hours worked, and capital stock per hour worked in accounting for growth in real product per hour worked. The sum of the contributions of these three sources of growth in real product per hour worked is equal to the contribution of real factor input per hour worked. We conclude that growth in real factor input per hour worked is more important than growth in total factor productivity in accounting for the growth in real product per hour worked for the period 1960–73 and less important for earlier periods ending in 1960. The most important contribution to growth in real product per hour worked is provided by growth in capital stock per hour worked. Growth in capital quality is somewhat more important than growth in labor quality, but the contributions of these two sources of growth are comparable in magnitude.

Further analysis of international and intertemporal differences in the growth of capital input and the growth of labor input requires a detailed characterization of sources of growth of these inputs. Growth in capital input involves growth in capital stock as a component of wealth through saving and capital formation. A complete system of accounts, like that developed by Christensen and Jorgenson [5], is essential to the analysis of sources of growth of capital input through saving, capital formation, and accumulation of wealth. An analysis of the sources of growth in labor input through the supply of work effort is also required. The analysis of sources of growth in capital and labor input remains an important objective for further research on patterns of aggregate economic growth.

Literature Cited

1. Bureau of Economic Analysis. *Fixed Nonresidential Business and Residential Capital in the United States, 1925–75*. Washington, D.C., U.S. Department of Commerce, June 1976.
2. Christensen, Laurits R. "Entrepreneurial Income: How Does It Measure Up?" *American Economic Review*, 61 (September 1971), 575–85.
3. Christensen, Laurits R., and Dale W. Jorgenson, "Measurement of U.S. Real Capital Input, 1929–1967." *Review of Income and Wealth*, Series 15, No. 4, December 1969, 293–320.
4. ______. "Measuring Economic Performance, 1947–1973." Report to the Office of International Competitiveness, U.S. Department of Commerce, and the Bureau of International Labor Affairs, U.S. Department of Labor, 1975.
5. ______. "Measuring the Performance of the Private Sector of the U.S. Economy, 1929–1969." In *Measuring Economic and Social Performance*, edited by M. Moss. New York: National Bureau of Economic Research, 1973.
6. ______. "U.S. Real Product and Real Factor Input, 1929–1967." *Review of Income and Wealth*, Series 16, No. 1, March 1970, 19–50.
7. Christensen, Laurits R., Dale W. Jorgenson, and Lawrence J. Lau. "Conjugate Duality and the Transcendental Logarithmic Production Function." *Econometrica*, 39 (July 1971), 255–56.
8. ______. "Transcendental Logarithmic Production Frontiers." *Review of Economics and Statistics*, 55 (February 1973), 28–45.
9. Diewert, W. Erwin. "Exact and Superlative Index Numbers." *Journal of Econometrics*, 4 (May 1976), 115–46.
10. ______. "Aggregation Problems in the Measurement of Capital." Discussion paper 77–09, Department of Economics, University of British Columbia, 1977.
11. Fisher, Irving. *The Making of Index Numbers*. Boston: Houghton Mifflin, 1922.
12. Goldsmith, Raymond W. *A Study of Saving in the United States*. Princeton, N.J.: Princeton University Press, 1955.
13. Jorgenson, Dale W. "The Economic Theory of Replacement and Depreciation." In *Econometrics and Economic Theory*, edited by W. Sellekaerts, 189–221. New York: Macmillan, 1973.
14. Jorgenson, Dale W., and Zvi Griliches. "The Explanation of Productivity Change." *Review of Economic Studies*, 34, No. 99 (1967), 249–83.
15. Jorgenson, Dale W., and Lawrence J. Lau. *Duality and Technology*. Amsterdam: North-Holland, 1977.
16. Kloek, Teun. *Indexcijfers: enige methodologisch aspecten*. The Hague: Pasmans, 1966.
17. Theil, Henri. "The Information Approach to Demand Analysis." *Econometrica*, 33 (January 1965), 67–87.
18. Tornquist, Leo. "The Bank of Finland's Consumption Price Index." *Bank of Finland Monthly Bulletin*, No. 10 (1936), 1–8.

Comment

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This paper summarizes the results of a larger study of the United States and eight of its major trading partners for the period 1947–73 (where possible). The full study for the individual countries is about four inches thick and a number of interim reports have been presented. The major emphasis is on the measurement and contribution of the factors of production of labor and capital to the growth of total real product and output per man hour. Total factor productivity is derived as a residual, but has not been further broken down for any of the individual countries as part of the current project.

When I was asked to discuss this paper I was encouraged to be relatively nontechnical and to emphasize the policy implications of the study. My task has been made difficult by the inclusion of fourteen tables in the report, and the relative technicality of sections 2 and 3. The main theoretical portion of this paper has been published in essentially its present form in a number of previous articles and volumes of conference papers. The conference paper contains a narrative description of the seven major conclusions, but is devoid of policy implications (for either government or business) for the United States or the eight other countries.

The two most important themes emphasized by the authors of the study are (1) the importance of the contribution of total factor inputs, rather than output in relation to total factor inputs, to total growth in the nine countries studied; and (2) the importance of capital as a productive factor. Almost all seven conclusions in section 4 relate to these two themes—themes that have reappeared in their work since the initial 1967 study by Jorgenson and Griliches argued that the increases in real output could be almost completely explained by increases in total factor inputs if the factor inputs were measured properly. The detailed results for the United States as part of the current study have modified this to a significant degree as the increase in output in relation to total factor inputs is currently estimated as 1.05 from 1945 to 1965, compared to 0.10 in the 1967 article. This substantially alters the earlier conclusion that growth in total factor productivity plays a very small role in growth.

It should be noted that other recent studies for some of the same countries show quite a differing relative contribution of labor and capital inputs compared to total factor productivity over a roughly comparable time period. This is illustrated in Table 1 for the United States and Japan.

The differences in the share contributions of capital and total factor productivity to growth are large for both countries, especially for the United States. Two points seem particularly important to mention as reasons for that result. For one thing, the weights for the contribution of capital are much larger in this study than emerge in the studies initiated by Denison. This picks up a debate that has been going on for a decade. This arises because the current paper uses weights for share of capital in national income, which includes depreciation, residential structures and consumer durables—all of which are excluded from the income share to capital in the Denison results. Comparisons for eight countries are shown in Table 2. When the stock of capital is growing more rapidly than employment for almost all countries and time periods covered, the point contribution of capital input to growth is increased and the size of output in relation to total factor inputs is reduced by this larger weight for the contribution of capital. The current study also incorporates quality change in the capital stock, which works in the same direction. The "quality" adjustment for capital basically reflects the differences in weights between the flows of the services

Table 1
Share Contribution to Sources of Growth of National Income

	United States		Japan	
	1947–73	1948–69	1952–73	1953–71
	C.C.J	D.	C.C.J.	D.C.
Capital input	0.462	0.151	0.317	0.238
Labor input	0.242	0.256	0.264	0.210
Total factor productivity	0.296	0.594	0.418	0.552

Sources: Christensen, Cummings and Jorgenson, Table 12 (average of two subperiods for the United States and Japan) for columns 1 and 3; Edward F. Denison *Accounting for United States Growth, 1929–1969* (Washington: The Brookings Institution, 1974) Table 8-2, p. 111, for column 2; and Edward F. Denison and William K. Chung, *How Japan's Economy Grew So Fast: The Sources of Postwar Growth* (Washington: The Brookings Institution, 1976) Table 4-8, pp. 42–43, for column 4. There are some differences in periods covered and definitions of national income, but these would not be too important in the differences shown.

Table 2

Weights for Capital Inputs 1960–62

	Present Paper	Net National Income	Difference
Canada	.446	.219	+.227
France	.386	.223	+.163
Germany	.388	.258	+.130
Italy	.414	.180	+.234
Japan	.408	.279	+.129
Netherlands	.452	.252	+.200
United Kingdom	.381	.214	+.167
United States	.439	.201	+.238
Mean	.368	.203	+.165

Sources: Column 1 from Christensen, Cummings, Jorgenson, Table 2; Column 2 from Edward F. Denison assisted by Jean-Pierre Poullier, *Why Growth Rates Differ* (Washington: The Brookings Institution, 1967) Table 4-1, p. 38, Dorothy Walters, *Canadian Income Levels and Growth: An International Perspective* (Ottawa: Queen's Printer, 1968) p. 28, and Edward F. Denison and William K. Chung, *How Japan's Economy Grew So Fast* (Washington: The Brookings Institution, 1976) p. 28. There are slight differences in the definition of national income, as column 2 includes government and housing (except for the U.S. and Japan) but excludes capital consumption, and column 1 excludes both government and housing and includes depreciation. The largest differences arise in the income to capital as column 1 includes an imputation for the services of consumer durables and is gross of depreciation. The revised national accounts for Canada would lower the share to capital slightly from that shown in the table.

of capital, as they measure them, and the weights for the stock of capital. I merely want to note these differences without trying to debate or resolve the issues (For a further discussion of technical issues, see [2, 4, 5, 3, 1].)

It might be noted that the industry studies and others presented at the conference concentrate on manufacturing and the commodity-producing industries. When one considers these industries, it seems preferable to exclude housing and consumer durables from the income weights for capital.

In this paper the authors have not made any policy recommendations based on the series of studies to either government or business in the countries concerned. I am neither able to develop any policy implications from the study nor to see much policy relevance in the study as it stands without much further analysis. The last two sentences in the study suggest further analysis of "the supply of work effort" and the "sources of growth in capital and labor input." Orally at the conference, Professor Jorgenson emphasized the scope for encouraging capital to a greater degree than in the paper. How could such a study throw light on lower prices to consumers, larger real product in relation to factor inputs, or improve the balance of payments or some economic goal? Is capital stock the really central determinant of growth? Why is the study so disappointing in its relevance to the policy issues that are being considered in other papers at the conference? Let me analyze this by considering the research strategy options in international growth comparisons, using the following two-by-four simple conceptual table. These comments go beyond the current paper and deal with the broader questions of research strategy. Professor Jorgenson has under way additional studies that will explore some of these additional topics and questions.

Research Strategy Options

	Macro	Micro
Comparisons over time		
Factor inputs	Present study	
Output in relation to inputs		
Level comparisons		
Factor inputs		
Output in relation to inputs		

The present study was limited to the contribution of factor inputs over time and did not attempt the interesting task of quantifying the contribution of economies of scale, interindustry shifts, and the scope for technological change. Furthermore, other studies provide additional illumination from making level comparisons between countries at a point in time *in addition to* making comparisons over time with the same conceptual framework; in this they are helped by the Kravis data on levels, but needed data on differences in education, capital, and capital quality are not in the public domain. An analysis covering both is much more interesting than either alone, and the cost of doing them simultaneously is less than doing them both independently.

Another direction that can be fruitful is to do more industrial disaggregation. This is the direction that Professor Jorgenson has begun to take both for the United States over time and Japanese-United States comparisons at a point in time. The current study is limited to the private domestic sector, excluding government but including housing. However, a major part of the covered sector involves "nontraded goods," to use the currently popular phrase in international trade literature. Much of the output of the service industries is produced and purchased in local markets. The interesting issues of growth, productivity, and trade relate to production and marketing in the commodity-producing industries of manufacturing, agriculture, mining, and petroleum. It is interesting that all the papers presented previously at this conference have emphasized the micro aspects, with important policy applications.

It might be of interest that some of the initial work on international growth comparisons in Canada started at the aggregative level, using the Denison framework, but quickly shifted to manufacturing. The role of tariffs, science policy, monetary policy, and business management in the price, productivity, and cost position of Canadian manufacturing in relation to the United States has been looked at in this general perspective. Canada's comparative advantages and disadvantages in factor supplies and productivity differences have been analyzed in relation to both the United States and Japan. Output per person in Canadian mining is 65 percent higher, and in manufacturing, 25 percent lower than in the United States. Capital stock per person in Canada is higher than in the United States, but output per person is lower. The studies have also had implications for economic theory and such topics as the economies of scale, the influence of tariffs on the distribution of national income, and intraindustry specialization in international trade. Research costs have been relatively small, but policy implications have been both important and controversial.

Let me mention an interesting area in the Japan-United States comparisons. Yukizawa's [6] comparisons of output per person in about two hundred individual manufacturing industries (done for 4 years over a 15-year period) suggest the levels in manufacturing output per man are much closer to North American levels than suggested by the aggregative results for GDP obtained by Kravis and associates. The aggregate for Japan relative to North America has been held down by much lower levels of output per person in agriculture and the service industries. After a sharp drop during the recession, manufacturing output per man and per man hour has been increasing sharply since early 1965 and now approaches North American levels, even though the stock of capital per worker is substantially lower. Are product-specific and plant-specific scale economies for individual manufacturing products in Japan similar to those in other industrialized countries, or different? Will the more rapid diffusion of new technology slow down as the Japanese begin to attain the levels of the most industrialized countries, or could they surpass the United States, as France and Germany have surpassed the United Kingdom in the period since the Second World War? What are the costs and benefits of a science policy that emphasizes new research and development (as Canadian policy has), or of one that emphasizes the diffusion of technology (as Japanese policy has)? What are the implications for steel and autos in the United States if the increases in output per person and in relation to total factor inputs in Japan become substantially greater than in the United States once again? These research questions can be important for the direction of trade and domestic adjustments on the employment side in the United States and other industrialized countries.

I would encourage the United States Department of Labor to emphasize additional research on these important questions in future research plans.

Addendum

In the oral presentation at the conference, Professor Jorgenson added further comments on the policy implications of the study, recommending encouragement to add to the capital stock in the United States, presumably the business portion, in the form of reproducible fixed assets.

The reader is reminded that Table 3 in the paper shows the share of nonresidential structures and producer durables as about 30 percent of the total capital stock. The balance relates to consumer durables, residential structures, inventories and land. Should all, or only some, of these categories be encouraged?

In connection with business capital stocks, the available evidence indicates that the existing capacity was being utilized at quite low rates, even before the additional underutilization since 1974 emerged. (See [6].) Can one really defend incentives to add to business capital facilities if the existing facilities are being operated at such low rates of utilization?

I am sure that union economists and union members would like to raise these and other questions about the policy implications of the study suggested orally at the conference by Professor Jorgenson.

Literature Cited

1. Daly, Donald J. "Combining Inputs to Secure a Measure of Total Factor Input." *Review of Income and Wealth* (March 1972), 27–53.
2. ———. Discussion of "Economic Growth, 1947–1973: An International Comparison," by Christensen, Cummings, and Jorgenson. In *Recent Developments in Productivity Measurement*, edited by John Kendrick and Beatrice Vaccara. New York: Columbia University Press for the NBER, forthcoming.
3. Denison, Edward F. "Classification of Sources of Growth." *Review of Income and Wealth*, Series 18, no. 1 (March 1972), 1–25.
4. ———. "Some Major Issues in Productivity Analysis: An Examination of Estimates by Jorgenson and Griliches." *Survey of Current Business* (May 1972), 37–63.
5. Jorgenson, Dale, and Zvi Griliches. "Issues in Growth Accounting: A Reply to Edward F. Denison." *Survey of Current Business* (May 1972), 65–94.

6. Winston, Gordon C. "The Theory of Capacity Utilization and Idleness." *Journal of Economic Literature*, 12 (1974), 1301–20.

7. Yukizawa, Kenzo. "Japanese and American Productivity: An International Comparison of Physical Output per Head." Mimeographed. Kyoto: Kyoto Institute of Economic Research, 1975.

Reply

Laurits R. Christensen, Dianne Cummings, and Dale W. Jorgenson

Productivity growth is a serious candidate for any list of leading policy concerns of the next decade. The results of our study reveal that it is difficult to exaggerate the need for policies to stimulate U.S. productivity growth. Between the periods 1947–60 and 1960–73 U.S. productivity growth dropped from 3.1 percent per year to 2.7 percent. During the period 1960–73 the United States trailed every major industralized country, including the United Kingdom, in productivity growth.

Our study also suggests some useful directions for the additional work required to develop an analysis of policies to stimulate productivity growth:

1. Growth of capital stock per hour worked is the most significant of the three sources of productivity growth we have analyzed. Capital is not limited to business fixed capital, as suggested by Daly in his comments, and measures to stimulate capital formation should not be limited to industrial plants or to producers' durable equipment.

2. Growth in capital and labor quality are roughly equal in importance as sources of productivity growth. Policies to stimulate growth in the quality of factor inputs will enhance the effectiveness of utilization of both labor and capital in the process of production.

3. Growth in work effort through increased labor force participation and increased employment is an important source of economic growth. For the next two to five years policies to provide productive employment opportunities should have top priority.

Previous international comparisons of productivity growth have supported the conclusion that growth of real factor input is a much less significant determinant of productivity growth than growth in total factor productivity. This conclusion has very important policy implications. It implies that policies to stimulate growth in productivity should emphasize measures to augment the growth of total factor productivity rather than measures to increase the supply of labor and capital input.

By contrast our results show that the emphasis has been misplaced. Growth in real factor input and growth in total factor productivity are equally important in accounting for productivity growth. Differences between time periods for a given country and differences among countries show that variations in productivity growth rates are mainly due to variations in rates of growth of factor input. This conclusion implies that policies to stimulate the supply of labor and capital input can have substantial impact on the rate of productivity growth.

Daly correctly emphasizes the central importance of our methodology for measuring capital input in our analysis of productivity growth. It is equally important to emphasize that our studies cover a much broader range of historical experience than the studies by Denison and his associates cited by Daly. Unfortunately, Denison's studies are based on a defective methodology that fails to treat labor and capital input symmetrically.

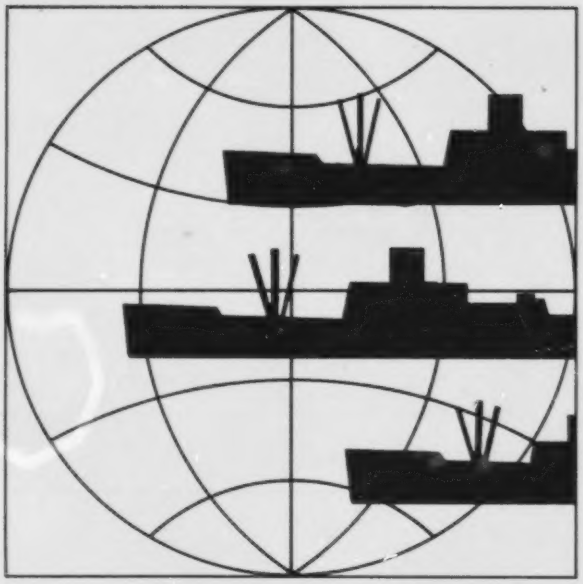
Labor inputs should be weighted by wage rates, reflecting the cost of using labor in the production process. Capital inputs should be weighted by annualized costs, including all components of the cost of using capital — the rate of return, taxes, and depreciation. The marginal productivity of labor is understated if any component of labor costs is omitted. Similarly, the marginal productivity of capital is understated if any component of capital costs is omitted.

Denison and his associates have pioneered in the measurement of labor input. However, Denison has failed to incorporate a symmetrical approach to capital, so that his measures of capital input are not consistent with his measures of labor input. His results completely distort the analysis of sources of economic growth and result in misleading recommendations for policies to stimulate productivity growth. Daly has provided useful documentation of sources of differences between our results and Denison's.

Daly has pointed out that much additional work is required to support detailed policy analysis of measures to stimulate productivity growth; we endorse all of his very useful suggestions. Finally, it is a pleasure to thank Daly for providing a careful and thoughtful set of comments on our paper. His suggestions have given us a great deal to think about and we hope that readers of his comments will share his enthusiasm for support of additional research on the questions he has raised.

Part Six

U.S. Tariff Policy



Introduction

William G. Dewald

In the years from the Smoot-Hawley Tariff Act in 1930 to the Trade Expansion Act in 1962 the majority of U.S. businessmen switched from supporting trade restrictions generally to supporting them only for their own industry. During this interval the American union movement may have switched from neutrality on international trade liberalization to support of the Trade Expansion Act. But since 1962 the union movement has come to represent perhaps the most formidable opposition to further trade liberalization. The opposition appears to be quite general and to be opposition in principle. There certainly have been numerous cases of workers who lost their jobs in industries injured by foreign competition. But it is common sense, at least among us academic economists, to expect that, if one looks at industrial employment in enough detail, there must be industries and workers that would be benefited by additional foreign trade. Last night a distinguished labor leader asked me which industries would be benefited by trade liberalization. In my most pleasant and evasive way I said "lots." He wasn't satisfied with my answer. Nor should he have been. The papers in this section are far more specific than I was in terms of particular industries that would probably be affected favorably, unfavorably, or not at all by expanded trade, and they also have a contribution to make in terms of estimating the aggregative disruptions that trade liberalization might impose on U.S. production, employment, and international trade patterns.

The studies reported in this session on tariff negotiations are industry studies in the broad sense of looking at a wide spectrum of industries unlike the one-industry studies discussed earlier. But in contrast, and very importantly, the papers attempt to account for a variety of indirect effects in assessing the likely *net* benefits or costs of tariff changes in terms of real incomes as well as the distribution of such benefits and costs to consumers and to particular workers in particular industries. The authors identify a variety of very detailed results, in fact, more detailed results than have ever before been prepared in studies of this kind.

Perhaps the most striking result that is general to each of the three papers is that the employment effects of tariff changes in the aggregate are comparatively small, at least in comparison with employment variation that is the result of the business cycle. If true, it may be reasonable to conclude that monetary and fiscal policy could encompass any aggregative employment effects of tariff changes within the domain of countercyclical policies. Nevertheless one can't be altogether sanguine about this conclusion for several reasons. First, the more detailed results in the Robert Baldwin-Wayne Lewis and William Cline-Noboru Kawanabe-T.O.M. Kronsjo-Thomas Williams papers really don't take into account the possibility that simultaneous tariff changes might add up to a different total effect than the sum of the changes introduced separately. To some extent this possibility is explored in the general equilibrium framework of the Wharton industry model in the work of Ross Preston as reported by Lawrence Klein. But a gnawing doubt remains. Second, the detailed studies found that there are significant effects on the demand for labor in particular places and in particular industries that would require in some instances quite a massive redistribution of workers to new jobs. Such a transition could be very painful and costly to individuals; and presumably to the society they compose. The transition involves a period of job search, sometimes with so little prospect of finding another job that the worker gives up. Even the successful job seekers often experience a spell of unemployment before finding a new job. And it, at least initially, may well pay a lower wage than the job that was lost. Such costs are real costs and must be assessed along with benefits to the nation as a whole in appraising the appropriate stance of the U.S. government in trade negotiations.

As in any empirical work, the studies reported in this section do not deal with theoretical certainties but with real world probabilities. The results are incomplete as is all empirical work. Nevertheless, they represent what I believe to be among the best available information about the effect of changes in tariffs on U.S. income, employment, and trade patterns.

U.S. Tariff Effects on Trade and Employment In Detailed SIC Industries

Robert E. Baldwin and Wayne E. Lewis*

Introduction

This paper summarizes the trade and employment effects in the United States of a significant multilateral reduction in trade-distorting measures by the world's major trading nations. By estimating not only the net trade and employment effects of a significant tariff reduction in over 350 industries but also in the fifty states and on some fourteen occupational groups, it is hoped that the results will be useful for those who are now embarked on the Tokyo round of trade negotiations within the framework of the General Agreement on Tariffs and Trade (GATT). A novel feature of the study is the estimation of the net employment effects of multilateral tariff cuts under the assumption of flexible exchange rates.

The analytical framework for estimating the trade and employment effects of tariff reductions is presented in part 1. A key assumption of the model is that imports are imperfect substitutes for domestic production. Although trade models often employ an assumption of perfect substitutability, a more appropriate model for most U.S. commodity trade is one in which imports and domestic production are imperfect substitutes and supply curves for each of these types of goods are infinitely elastic. Also, in order to eliminate any macro effects, it is assumed that total government expenditures and tax revenues remain unchanged. It is assumed that when import duties are changed, income taxes are modified in such a way as to hold total tax revenue constant.

Part 2 describes the data sources employed in the study. The requisite trade and tariff data were collected for 1971 on a tariff-line basis by the GATT secretariat from the major trading countries. The industry breakdown employed corresponds to the 367-sector delineation of the 1967 U.S. input-output table. Five additional sets of data were utilized in estimating the trade-balance impact of multilateral tariff reductions and the associated employment changes. They are import and export demand elasticities for the 310 trading industries in the 367-sector input-output table; employment coefficients classified on the same industry basis; a breakdown of employment in each industry by skill groups; a breakdown of employment in each industry by state; and finally a set of price deflators to put the 1971 trade figures on a comparable basis with the 1967 input-output and labor-output coefficients used in the study.

Estimates of the trade and employment effects in the United States of a 50 percent multilateral tariff reduction are presented in part 3. The larger study from which the present paper is drawn also considers "harmonization" formulas for reducing tariffs, which specify that the higher is the initial tariff rate, the greater will be the percentage cut in the tariff. The economic arguments for harmonization are examined and estimates of the trade and employment effects under various harmonization formulas are presented in the full report to the Department of Labor.

Certain U.S. commodity exports and imports (mainly textile and agricultural products) have been excluded from the tariff-cutting process because they are subject to nontariff barriers that operate independently of tariffs. Cutting duties on these items will not increase trade. Five alternative sets of trade elasticities are used in the calculations. Based on the preferred set of export and import demand elasticities (set 1), a 50 percent duty reduction leads to changes in exports and imports that each exceed $1.5 billion in 1971 prices. However, the net trade change is a negligible $+4 million for tariff cuts in all industries and $−126 million if tariffs are cut on manufactures alone. The net employment impact is also small: −15,200 man-years for all industries and −31,700 man-years for manufacturing.

Some indication of the distribution effect of tariff reductions can be obtained by breaking down aggregate employment changes into various skill groups. Dividing net employment changes into fourteen occupational classes yields percentage changes in labor requirements ranging from +0.47 percent for farmers and farm managers to −0.14 percent for operatives. Similarly, the regional distribution of employment effects may be of interest to trade negotiators, and therefore the state-by-state employment impact of a 50 percent duty reduction is estimated (Table 6).

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*This paper is based on Robert E. Baldwin, "U.S. Tariff Policy: Formation and Effects" which was completed in 1976 under ILAB contract 74-11.

Although overall trade and employment effects of a 50 percent tariff cut are small under the most likely sets of trade elasticities, this does not mean that no industry is significantly harmed or benefited from the duty reductions. If one-half of one percent of an industry's labor force is arbitrarily chosen to divide industries that are or are not significantly affected, there would be 54 import-sensitive industries and 19 export-oriented industries. If tariff cuts in import-sensitive industries were phased over the full ten years permitted by the Trade Act of 1974, normal industry growth may offset the tariff-related employment declines in 33 of the 54 import-sensitive industries.

All the results mentioned thus far are impact effects; they do not include the effects of the exchange-rate change required on the part of the United States to eliminate any deficit or surplus pressures on the trade balance as a result of tariff cuts. For three plausible sets of trade elasticities (1–3), the required percentage exchange-rate changes needed for a 50 percent tariff cut on all industries are within a range of +0.003 to −0.688. The extreme elasticity assumptions used in sets 4 and 5 yield +2.43 and −2.46, respectively. There are still labor demand effects even though there is no trade-balance impact, but these changes are small for all elasticity sets.

A final exercise in part 3 is to convert the nontariff trade distortions in agriculture and the textile industry into their ad valorem equivalents and then to estimate the trade and employment effects of reducing their protective levels by 50 percent. Net exports of agricultural products would increase by $320 million and net imports of textile products would rise $965 million. The net employment changes in agriculture and the textile industry are +1,135 and −88,000 man-years, respectively.

The main conclusion emerging from this empirical analysis is that a substantial multilateral tariff-cutting exercise can be undertaken without causing significant adverse aggregate trade and employment effects in the U.S. economy. Even without taking into account exchange-rate changes, any adverse trade and employment effects are very small, except under one extreme set of elasticity conditions. However, when exchange-rate variations are taken into account, net trade changes are eliminated and aggregate employment shifts become minimal even under the most adverse elasticity assumptions.

Some of the key assumptions of the model tend to exaggerate the adverse effects of the tariff reductions of employment. Specifically, it has been assumed that foreign exporters reduce their prices by the full amount of the duty cut; to the extent that they do not, imports into the United States will rise less than indicated by the estimates reported here. This means that less domestic employment will be displaced. Utilizing 1971 trade data for the estimates further exaggerates any adverse effects. The dollar was still overvalued in that year and thus the trade balance was less favorable than under current conditions (ignoring oil imports, of course).

1. The Model

A key assumption of the model is that imports are imperfect substitutes for domestic production. Thus, the import demand for a particular good q_m can be written as follows:[1]

$$q_m = f_m \left(P_f \cdot (1/E) \cdot (1 + t + b)/P_y, P_d/P_y, Y/P_y\right), \quad (1)$$

where P_f is the foreign currency price of the import good, E is the exchange rate (the number of units of foreign currency per unit of domestic currency), t is the tariff rate on imports, b is the rate on imports of international transport and insurance costs,[2] P_d is the price of the domestic substitute, P_y is the price of all products consumed domestically other than the import good and its domestic substitute, and Y is domestic money income. Similarly, the demand for the domestic substitute q_d depends upon its own price P_d, the price of the foreign substitute P_m, the price of all other goods P_y, and money income Y:

$$q_d = f_d \left(P_d/P_y, P_m/P_y, Y/P_y\right). \quad (2)$$

Finally, the demand for exports q_x depends upon the price of the domestic product being exported P_d, the exchange rate E, the foreign tariff rate t_f, the rate on exports of international transport and insurance costs b', the foreign currency price of the foreign substitute P_f, the foreign currency price of other products consumed abroad P_{yf} other than the export good and its foreign substitute, and foreign money income Y_f:

$$q_x = f_x \left(P_d \cdot E \cdot (1 + t_f + b')/P_{yf}, P_f/P_{yf}, Y_f/P_{yf}\right). \quad (3)$$

The perfect substitution model is reasonable for dealing with agricultural products and raw materials but is not appropriate for the large volume of U.S. trade in manufactures. It is clear from direct observation that imports of most manufactured goods are only imperfect substitutes for domestic goods with which they compete. Moreover, empirical estimates for manufactured goods of domestic and import demand elasticities and of domestic supply elasticities give inconsistent results, if a perfect substitution model is assumed. The latter model implies the following relationship:

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[1] An appendix to this paper covering in detail the effects in the model of a change in import prices on expenditures for domestic goods and imports is available from the authors on request.

[2] The price of an imported good in domestic currency (P_m) equals $P_f \cdot (1/E)\,(1 + t + b)$.

$$e_m = \left(1 + \frac{O_s}{O_m}\right) e_d + \frac{O_s}{O_m} \cdot e_s, \qquad (4)$$

where e_m and e_d are the import and domestic demand elasticities and e_s is the domestic supply elasticity. The levels of domestic output and imports are O_s and O_m, respectively. Suppose one assumes that the import demand elasticity for a product is 3, the domestic demand elasticity is 0.3, and the ratio O_s/O_m is 10. Solving for e_s yields a figure of only 0.267. Raising the estimate for e_m and lowering those for e_d and O_s/O_m will increase the implied figure for the supply elasticity but even numbers at the extremes of empirical estimates for these variables still tend to yield low supply elasticities. For agricultural and mineral products, direct estimates of supply elasticities are in fact quite low. However, the results of numerous empirical studies of U.S. manufacturing industries indicate that short-run and long-run supply functions tend to be highly elastic.[3] Thus, either the methods of estimating these various elasticities have been faulty or the perfect substitution model is inappropriate. Though there are bias problems in estimating elasticities, they do not appear to be significant enough to account for the differences in supply elasticities obtained from actual estimates and those implied in the perfect substitution model from a knowledge of e_m and e_d.

The most appropriate approach would seem to be to employ a perfect substitution model for agricultural and mineral products that introduces less-than-completely elastic supply curves and an imperfect substitution model with infinitely elastic supply curves for manufactured products. This approach will be followed in subsequent work, but the part reported here utilizes the imperfect substitution model for all commodities and assumes infinitely elastic domestic supply curves. Since exports of agricultural and mineral products to the eighteen GATT countries which cut duties amount to only 10 percent of our total exports to these countries and agricultural barriers are not likely to be reduced significantly, the distorting effects of this assumption are reduced. In any event, the results of cutting duties on manufactures alone will always be reported separately.

Another assumption made in the model, namely that all import supply curves are infinitely elastic, has been frequently used in estimating the effects of tariff reductions.[4] In fact, however, recent experiences with devaluation seem to suggest that foreign suppliers will reduce their prices somewhat in response to a reduction in U.S. import demand.[5] The failure to introduce a finite import supply elasticity tends, consequently, to overstate the actual increase in imports and decrease in employment that tends to result from tariff reductions.

The use of infinitely elastic domestic and import supply curves within the framework of an imperfect substitution model obviously greatly simplifies the analysis. However, it also raises the necessity of coming up with estimates of cross elasticities of demand between imports and domestic production. Unfortunately there are very few studies of such elasticities for individual industries.[6] Until reliable estimates of cross-price effects are available on a detailed industry basis, it is therefore necessary to make some simple but reasonable assumptions concerning the effect of price cuts in import goods on the quantity demanded of the domestic substitute. The one that will be used here is that expenditures on the domestic substitute are reduced by a sum equal to the foreign costs, i.e., costs exclusive of remaining duties, of the additional imports purchased in response to the price reduction.

Figure 1 can be used to illustrate this assumption. Let the slopes of *AE* and *AF* reflect the post-tariff domestic price and free trade price, respectively, of imports. The equilibrium position for the consumer when the government redistributes the tariff proceeds is *C*, whereas the free trade equilibrium consumption point is *D*. With the tariff, the money income of consumers including a subsidy equal to the tariff proceeds is *OK*. Under these circumstances they spend *KG* of money income for *GC* of the import good. However, *KA* of money income goes to the government as tariff proceeds so that foreigners receive only *AG* of money income for the goods they sell. When the tariff is removed, consumers spend *AH* of their money income of *OA* on the import good and receive in return *HD* of this good. The increase in

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[3] [14]. For a recent study that supports the infinitely elastic supply assumption, see [8].

[4] See Magee [5, 665n.]. As Magee notes, estimated values of this function for the United States are high enough to make this a fairly innocuous assumption.

[5] For example, Clark found that a 1 percent change in U.S. demand for finished manufactures caused foreign producers to change their price by 0.32 percent [3].

[6] Two studies that estimate cross elasticities of demand between imports and domestic production are [9; 7, chap. 2].

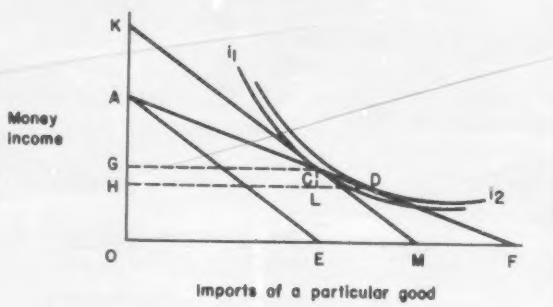

Figure 1

imports resulting from free trade is *LD* and the sum paid for these additional imports is *CL*. It is assumed that this sum is withdrawn entirely from purchases of the domestic substitute. In the tariff case, the additional sum spent on imports is also equal to the change in the total sum paid foreigners for imports. Thus, the value of imports plus the amount spent on the substitute home product remains constant.

Figure 2 also shows these relationships. Let S_f and S_{f+t} be the foreign supply curve and tariff-inclusive foreign supply, respectively; S_d is the domestic supply curve; and D_m and D_d are the import and domestic demand curves. When the duty is eliminated, purchases of imports by the country increase by the area *ACDB*. The demand curve for the domestic substitute shifts to the left and domestic consumption of this product falls from *OG* to *OF*. The decline in spending on the domestic good *FHJG* is made equal to the cost of the additional imports. Figure 2 appears on page 249.

Thus far, no mention has been made of the indirect effects on output of changes in final demand. However, an increase in, for example, the demand for automobiles will not only increase output and employment in the automobile industry but also in the industries that supply the automobile industry with intermediate inputs, i.e., steel, paint, rubber, etc. When final demand changes take place in many industries at the same time, these indirect output and employment effects can be considerable and must be taken into account. To do this a matrix of the direct and indirect input-output coefficients is needed for all industries. The industry vector of net changes in final demand is pre-multiplied by this matrix to obtain the change in output by industry resulting from the change in final demand. These output changes by industry are then multiplied by the appropriate marginal labor/output coefficients for the industries to obtain changes in employment.

Income Effects and Exchange Rate Changes

The increase in value of imports (ΔM) of a particular product (which also equals the decrease in value of expenditures on its domestic substitute) with a given Y, P_d, P_y, and E can be written:

$$\Delta M = M \cdot e_m \cdot \frac{\Delta t}{t+1}, \tag{5}$$

where M equals the initial import value, e_m is the elasticity of import demand, t is the tariff rate on the import good, and it is assumed that income taxes rise by the amount of the decrease in tariff receipts in order to hold government revenue constant.[7] When other duties are cut simultaneously, P_y and P_d do not, in fact, remain constant, since the cost of imported inputs used to produce domestic goods declines. The supply price of the import good P_f also declines as the costs of imported inputs for foreign suppliers decrease. Conceptually, substitution effects between imports and domestic goods (and exports and their foreign substitutes) as their prices decline differently in response to lower costs of imported inputs should be taken into account in the analysis. However, because a knowledge of foreign input-output relationships would be required to make these calculations and the differential price and thus substitution effects are exceedingly small empirically, the simulation results reported in the paper do not include these effects.

Another income effect of tariff reductions that must be considered in a fixed exchange rate model is the impact of shifts in the trade balance. It is usually assumed in such models that the monetary authorities vary the money supply so as to maintain investment at a constant level and that less than full employment with fixed wages and excess capital capacity exist in the economy. Therefore, the income consequences of trade-balance changes can be handled by the standard multiplier analysis (see, e.g. [1]). Further changes in trade and employment can then be determined from these income changes. These various assumptions are made in the model, but rather than proceed with a multiplier analysis, the model followed here assumes that the exchange rate is flexible and adjusts to eliminate surplus or deficit pressures in the trade balance and thus any net change in money income.[8] The various assumptions made thus far together with the fact that the imports are a small fraction of GNP in the United States enable one to move from the impact effects of changes in tariff rates on many individual items to such macro variables as exchange rates. This equilibrium condition for the balance of trade can be written

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[7] Strictly speaking, e_m in equation (5) is the income-compensated elasticity of import demand. Actual estimates of these elasticities are uncompensated import demand elasticities. Since all dutiable imports in the United States are 5 percent of GNP, the difference in these elasticities for any one item will be negligible.

[8] As will be seen later in the paper, the trade impact of a 50 percent tariff cut is so small that aggregate feedback effects on trade of a multiplier process would be very small.

$$\Sigma \Delta q_x P_d - \Sigma \Delta q_m P_f \frac{1}{E} = 0. \qquad (6)$$

One can think of the effects of a multilateral tariff reduction as taking place in two steps. Impact changes in the value of exports and imports caused by the duty reductions are first determined under the assumption that the exchange rate is fixed. Then, since with completely elastic import and export supply curves an exchange rate depreciation [appreciation] of x percent raises [lowers] all import prices to domestic residents by

$$\left(\frac{100}{100-x} - 1\right) \cdot 100\% , \left[\left(1 - \frac{100}{100+x}\right) \cdot 100\%\right]$$

and lowers [raises] all export prices to foreigners by x percent, the exchange rate change, i.e., the uniform price change, necessary to eliminate the trade deficit or surplus resulting from the tariff cut is then determined.[9] Although the final position is one in which no net change in trade balance has occurred, net employment changes are possible because of compositional changes in domestic production.

2. Data Sources

Trade Data

Probably the most serious data problem faced by prior investigators attempting to analyze the detailed economic effects on the U.S. economy of reducing duties has been the lack of suitable information on foreign trade and tariffs. To obtain a complete picture of trade and employment effects, it is necessary to know the exports of each domestic industry to each foreign country participating in the negotiations as well as the tariff rates facing each industry in the different countries. Otherwise, the effect on U.S. exports of duty cuts by other countries cannot be determined. Calculating ad valorem tariff equivalents on a detailed basis for the major trading nations is an enormous job that is beyond the financial capability of any single investigator. Even governments have found this task to be very difficult, although some efforts along these lines were made during the Kennedy Round.

Fortunately, in the late sixties the Office of the Special Trade Representative recognized the importance of these data for future negotiations and through the GATT persuaded other major trading nations to provide the secretariat with their relevant trade and tariff data. The secretariat then put this information on a comparable basis and provided it to all members in printed form and on magnetic tape. Trade flows for 1970 and 1971 are listed along with post-Kennedy Round tariff data on the GATT tape on the basis of the Brussels Tariff Nomenclature (BTN) for nineteen countries: United States, Japan, Canada, Austria, New Zealand, Finland, Switzerland, Sweden, Australia, Norway, and the nine European Community (EC) countries; namely, France, Germany, Italy, Netherlands, Belgium, Luxembourg, Denmark, United Kingdom, and Ireland. The data are presented on a 4-digit BTN basis for these countries and cover all ninety-nine chapters of the BTN. The trade and tariff information is also listed on the basis of each country's own tariff schedule, e.g., the TSUS schedule for the United States or the 8-digit BTN schedule for the EC countries.

Unfortunately, ad valorem equivalents of the variable levies of the European Community on agricultural items are not available on the tape. However, through the efforts of Larry Wipf of the Foreign Economic Research Office of the Bureau of International Labor Affairs in the Department of Labor, these rates were calculated for 1971–72. Wipf also calculated ad valorem equivalents for U.S. imports of agricultural commodities subject to quantitative restrictions.

Since this study deals with the trade of the United States on which concessions will be made or received, it utilizes only that part of the GATT tape listing both U.S. imports from all countries and imports from the United States (U.S. exports) by the eighteen other countries covered in the tape. Of all the countries included, only the United States, Canada, New Zealand, and Australia present their trade data on an f.o.b. basis (all others express import figures in c.i.f. terms). Therefore, U.S. exports, as measured by imports of the other countries from the United States, are on a c.i.f. basis except for Canada, New Zealand and Australia. On the other hand, U.S. import data as reported on the tape are in f.o.b. terms. In order to put all data on a comparable c.i.f. basis, c.i.f.-f.o.b. corrective factors for imports taken from the 1967 U.S. 367-sector input-output table were utilized. These were applied not only to U.S. import figures in order to express them in c.i.f. terms but also to imports by Australia from the United States (U.S. exports to Australia). However, they were not applied to Canadian and New Zealand imports from

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[9] An appendix to this paper dealing with the exchange rate required to achieve a desired change in the balance of trade is available from the authors upon request.

Table 1

Trade, Average Duty Levels, and Dispersion Measures by Country, 1971

		Imports from the United States										
	U.S. Imports	Australia	Austria	Canada	EC	Finland	Japan	New Zealand	Norway	Sweden	Switz-erland	18 GATT Countries
Dutiable Imports (in millions of $s)*	34,758.9	421.3	48.1	4,048.7	7,993.4	56.8	3,097.9	96.7	104.8	346.1	434.4	16,648.2
Trade-weighted av.-duty (T-w av.)	7.4	23.2	15.0	12.7	9.1	7.8	11.1	26.2	9.8	6.3	2.2	10.6
Unweighted av.-duty (U av.)	9.9	27.2	15.0	14.5	10.4	12.3	11.7	32.6	10.8	7.2	4.6	14.4
Trade-weighted standard deviation (T-w sd.)	6.8	17.4	9.4	5.9	5.8	8.0	5.7	19.5	7.4	3.3	3.9	7.3
Unweighted standard deviation (U sd.)	8.7	17.2	8.9	5.3	7.6	4.1	6.6	29.9	9.2	3.7	5.2	14.6
Total Imports (in millions of $s)*	50,090.4	1,012.6	133.5	10,400.5	10,320.9	124.9	4,883.4	142.6	240.5	542.5	484.3	28,285.7
T-w av.	5.1	9.7	5.4	4.9	7.1	3.5	7.1	17.8	4.3	4.0	2.0	6.2
U av.	8.7	15.8	12.4	8.8	9.6	8.4	10.9	26.0	8.7	5.9	4.5	11.0
T-w sd.	6.6	16.0	9.2	7.2	6.4	6.6	7.1	20.2	6.9	4.0	3.7	7.6
U sd.	8.8	18.7	9.9	8.3	7.8	10.6	7.0	29.8	9.3	4.4	5.1	14.1
Dutiable Imports excl. Textiles, Oil, etc.†	27,748.2	401.1	46.9	3,875.8	7,826.9	55.9	3,071.5	92.6	102.3	336.1	425.9	16,235.0
T-w av.	6.4	22.8	14.5	12.2	9.0	7.5	11.1	26.5	9.6	6.1	2.1	10.4
U av.	9.0	26.7	14.4	14.3	10.3	11.0	11.7	32.4	10.1	6.7	4.2	14.0
T-w sd.	4.7	17.1	8.6	5.4	5.9	7.8	5.8	20.0	7.3	3.2	3.7	7.1
U sd.	8.3	16.9	8.5	4.8	7.7	9.8	6.6	30.3	9.0	3.5	5.0	14.5
Total Imports, excl. Textiles, Oil, etc.†	42,360.7	989.3	132.0	10,214.6	10,150.1	123.6	4,856.6	138.4	237.7	532.2	475.8	27,850.3
T-w av.	4.2	9.2	5.1	4.6	7.0	3.4	7.0	17.7	4.1	3.8	1.9	6.1
U av.	7.7	15.1	11.7	8.4	9.6	7.3	10.8	25.2	8.0	5.4	4.1	10.7
T-w sd.	4.9	15.6	8.7	6.9	6.4	6.4	7.1	20.3	6.7	3.9	3.6	7.4
U sd.	8.3	27.8	11.8	7.9	8.5	12.8	7.9	36.5	10.9	5.3	5.0	14.0
Dutiable Imports of Mfred. Goods ‡	30,300.5	395.8	45.6	3,879.5	7,288.4	49.7	2,390.3	89.0	100.9	344.2	422.3	15,005.7
T-w av.	7.8	21.4	14.8	13.0	8.8	7.8	11.4	25.8	10.1	6.2	2.2	10.5
U av.	10.1	27.3	15.1	14.6	10.3	12.1	11.7	32.7	10.8	7.1	4.7	14.4
T-w sd.	6.9	15.8	9.3	5.7	5.2	6.9	5.5	19.8	6.6	3.2	3.9	7.0
U sd.	8.7	17.2	8.9	5.2	7.6	10.3	6.6	29.7	9.0	3.6	5.2	14.6
Dutiable Imports of Mfred. Goods excl.	23,289.8	375.5	44.3	3,706.1	7,121.9	48.8	2,363.9	84.9	98.4	334.2	413.7	14,591.7
Textiles, etc. §	6.7	20.8	14.3	12.5	8.7	7.5	11.4	26.1	9.8	6.0	2.1	10.3
T-w av.	9.1	26.9	14.5	14.2	10.3	10.8	11.7	32.5	10.1	6.6	4.2	14.0
U av.	4.6	12.3	8.4	5.3	5.2	6.5	5.6	19.9	7.2	3.2	2.8	6.9
T-w sd.	8.2	16.9	8.4	5.0	7.7	9.0	9.0	30.1	8.8	3.5	5.0	14.5
U sd.												

Table 1 (continued)

Source: GATT Tape

Note: The table covers the trade on which the United States will make and receive concessions. This includes all imports and exports to the other eighteen countries on the GATT tape. Tariff averages and dispersion measures for the United States, therefore, are weighted by imports from all countries, whereas the duty averages and standard deviations for other countries are weighted by their imports from the United States. All tariff rates or ad valorem equivalents are based on statutory tariff rates in effect on January 1, 1973.

*Variable levy items of the EC are excluded.

†Textiles covered by the new international textile agreement are excluded both from U.S. imports and imports of the other countries from the U.S. U.S. oil imports and U.S. imports of agricultural goods subject to QRs as well as the variable levy items of the EC are excluded.

‡The definition of manufactured goods followed here differs somewhat from the convention followed under the BTN. Under the BTN, Chapters 1–25 are usually regarded as composed of agricultural and mineral goods and Chapters 26–99 as consisting of manufactured products. In this study, agriculture and mining are covered by sectors 1–12 of the U.S. input-output table and manufactured goods by sectors 13–64. The main difference is that processed food products (sector 14 in the input-output table) are regarded as manufactures in this study but agricultural goods under the BTN.

§U.S. imports and exports of textiles covered by the new international agreement as well as U.S. imports of refined petroleum are excluded.

the United States (U.S. exports to Canada). It was felt that using corrections based on imports from countries generally much farther away than Canada would create a greater distortion than leaving the Canadian data on an f.o.b. basis. No correction of New Zealand imports from the United States was made because of the relatively small volume of trade involved. Table 1 presents information from the GATT tape (with the above-mentioned f.o.b./c.i.f. corrections) on trade, average duty levels, and measures of tariff dispersion for U.S. imports from all countries and for imports of the eighteen other countries (U.S. exports) from the United States.

Interindustry Relationships

A second important data base for the study is the 1967 367-sector input-output table for the United States. As mentioned in part 1, a matrix of direct and indirect input-output coefficients is needed in order to measure the total output effects of a change in exports or imports. Until 1969 the most detailed table constructed by the government contained only 85 sectors or industries. This breakdown is too broad to be of much use for negotiators in making decisions about such matters as exceptions or possible sector negotiations. The 367-sector classification, however, is not so detailed as to be unmanageable in terms of common notions of what constitutes an industry nor so broad as to be of little use in dealing with distinguishable pressure groups.

Reclassifying the GATT data on imports from the United States (U.S. exports) for eighteen countries into the 367-sector system of the input-output table involved the following steps. The UN concordance [11] between BTN and SITC was first utilized to put the GATT data on an SITC basis. Then a concordance between SITC and SIC obtained from the Commerce Department and based on 1970 U.S. exports was used to express SITC exports of U.S. manufactured goods in SIC terms.[10] A similar concordance for agricultural and mineral goods was developed and employed to switch U.S. exports of these goods to an SIC basis. Finally, these SIC export data were rearranged into the 367 sectors used for the input-output table.[11] U.S. import data were taken from the GATT tape in their TSUS form and then expressed in SIC terms with the aid of a concordance developed by James Ozzello of the U.S. State Department.[12] These import figures were then shifted to the classification system of the input-output table by using the concordance in [13].

The 367-sector transaction table as well as its matrix of total input-output coefficients are, unfortunately, not on a domestic base. An input-output table constructed on a total base rather than a domestic base includes a row (80.02) listing what is termed "transferred imports." These are simply imports of goods that compete with domestic production and that are not distinguished from domestic output in the rest of the table. For example, the row for, say, copper ore mining includes the distribution by industry of both domestically produced and imported copper ore. In order to ensure that the last column and last row (total inputs and total outputs, respectively) of the table sum up to the same figure, it is necessary therefore either to put in a separate row showing transferred imports or a final demand column of negative numbers listing these transferred imports. Under the first arrangement one views each industry as purchasing imports of the final product produced by the industry and then distributing them to other industries and to final demand uses along with the output produced domestically. The 367-sector table used in the study follows this procedure. However, the 85-sector table for 1967 is available on a domestic base, and this table will be used in some subsequent parts of the study. The drawback of a total-base table is that imports appear twice in the table and thus bias analyses directed only at the domestic consequences of changes in final demand. However, it is too costly to shift the 367-sector table to a domestic base and invert the matrix of direct coefficients to obtain new direct plus indirect coefficients.

Although a domestic-base table corrects for the double counting of imports, the coefficients still include imports. Therefore, the direct and indirect supply changes for various industries as determined by premultiplying the change in a vector of final demand by the direct and indirect input-output coefficients will include both domestic and imported goods. If one is interested in only the change in domestic supply, the coefficients must be decreased to eliminate their import components. This is accomplished by multiplying the total coefficients of each row by the ratio: total intermediate use of the industry's products (which is composed of domestic and import goods) less transferred imports of the industry's products divided by total intermediate use of the industry's products.[13] Although the 367-sector table was not shifted to a domestic base, the direct and indirect coefficients from this table were modified along the above lines in order to remove their import content.

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[10] The Commerce Department concordance was based on the 1970 U.S export trade and the concordances given in [12].

[11] The SIC input-output system concordance is given in [13].

[12] This concordance also was based on [12].

[13] The method assumes that the share of imported inputs used by each industry is the same as the total import share for the input.

Elasticity Estimates

After classifying U.S. trade and tariffs by input-output industry the next step in estimating trade effects is to obtain elasticities of import and export demand for these industries. Several sources were utilized in this endeavor. One set of elasticities is composed of estimates by Margaret Buckler and Clopper Almon for some 45 manufactured goods and by Stephen Magee for crude foodstuffs, crude materials, and manufactured food [2, 4]. These are listed in the full report as elasticities set 1. A second set of elasticities is the same as set 1 except that import demand elasticities estimated by the International Trade Commission for 20 sensitive industries (15 industries in the input-output table) replace the import demand elasticities listed for these industries in set 1.[14]

In addition to these two lists of elasticities, three other sets are utilized. These are based upon a survey of the literature of elasticities by Robert Stern [10]. Table 2 lists these elasticities by I-O industry and SITC group. The three elasticity sets are obtained by using Stern's "best" estimates (which are equal to the approximate mean when several estimated values were available) for imports and exports, his high import and low export elasticities, and finally his low import and high export figures.

Thus far, the analytical framework has implicitly assumed that there are only two goods and two countries. In Figure 2, for example, the demand and supply curves of imports depict a particular commodity that is being exported from another country (often described as the rest of the world) to the country whose demand and supply relationships are indicated on the right-hand portion of the figure. However, the data base used in the study covers U.S. imports and exports in some 300 product sectors (each of which is, in turn, usually made up of a number of tariff-line items) from and to the enlarged European Community, each of 9 other industrial nations, and an "all other" country group. Thus, it is desirable to obtain elasticity estimates for disaggregated product groups.

The Buckler-Almon import and export demand elasticities, which are regarded as the preferred set for this

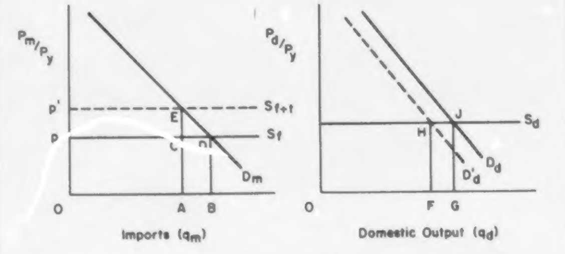

Figure 2

Table 2

Elasticity Estimates Based on the Stern Survey

		IMPORTS			EXPORTS		
Input-Output Industry	SITC Class	High	"Best"	Low	High	"Best"	Low
1.01-2.03, 2.05, 2.06, 3.00, 14.01-14.23	0,1	3.45	0.80	0.21	2.09	0.85	0.38
14.24-14.27, 2.04, 2.06, 2.07, 4.00, 5.00-6.02, 9.00, 10.00	2,4	0.90	0.43	0.02	3.10	0.86	0.31
7.00, 8.00	3	1.30	0.96	0.63	3.10*	0.86*	0.31*
All Others	5-9	5.00†	1.80	0.48	2.62	1.24	0.56

Source: [10].

*Stern does not give export elasticities for SITC group 3. Consequently, his values for SITC groups 2 and 4 are used.

†Stern's high figure for SITC 5-9 is actually 10.55 and is based upon a study by J. David Richardson, "Some Issues in the Structural Determination of International Price Responsiveness," presented at International Colloquium on Quantitative Studies of International Economic Relations, Namur, Belgium, January 31 - February 1, 1974. In view of Richardson's own skepticism about the figures and the fact that no other estimate of a broad aggregate of manufactures exceeds 4.72, the Richardson figure was not used for the high estimate.

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[14] The International Trade Commission elasticities (expressed as positive numbers) by input-output industry are: Veneer and plywood (20.06) .58; rubber footwear (32.02) 5.49; leather tanning (33.00) 2.42; footwear cut stock (34.01) 2.42; other leather products (34.03) 2.42; footwear, except rubber (34.02) 4.31; food utensils, pottery (36.07) 1.03; cutlery (42.01) .67; typewriters (51.02) .92; motor vehicles and trucks (59.03) 2.34; watches, clocks, and parts (62.07) .09; jewelry (64.01) 2.70; games, toys, etc. (64.03) 2.55; sporting and athletic goods (64.04) 1.45; and buttons, pins, needles, and fasteners (64.07) 2.68.

study, were estimated by regressing imports and exports by industry on the ratio of an industry's domestic to foreign price. For domestic prices they used the deflators for the output of an industry. As they point out, there is no satisfactory index of foreign prices. They used either German or Japanese export price indexes or a weighted combination of the two as representing foreign prices. Sometimes it was even necessary to employ broad export unit values calculated by the U.S. Department of Commerce for this purpose.

In estimating U.S. import effects of a tariff negotiation, one wishes to know the impact of a uniform price decline in all foreign export prices relative to the prices of U.S. domestic substitutes. Employing German and Japanese prices either singularly or in combination is not very satisfactory for this purpose if there are relative price changes among the various foreign exporting countries. A given average change in foreign prices can be achieved with many different combinations of price changes among individual foreign exporters. However, for the lack of better information the import demand elasticities of Buckler and Almon are used.

The inadequacy of the export demand elasticities that are employed in the absence of better data is even more apparent. The desired relationship sought is how U.S. exports to each country change when each country lowers its tariffs not only on U.S. goods but on the exports of every other country. If a particular change in the average of the foreign price index used in estimating export demand elasticities occurs by a decline in one country's export prices (which equals its domestic prices) and no change at all in export prices for the rest of the foreign exporters included in the index, using the change in foreign export prices relative to U.S. domestic prices as the bases of the elasticities needed for estimating the effects of a multilateral trade negotiation will overstate the increase in U.S. exports to the country. This will be the case because a multilateral tariff negotiation lowers the prices of all exporters to each country. However, there are some types of U.S. trade in which export prices of certain foreign exporters do in fact remain unchanged in a multilateral trade negotiation. For example, when the European Community (EC) lowers its external duties on U.S. goods, export prices for the members of the European Free Trade Area (EFTA) will not decline since there is already free trade between these two groups. The same holds true for the EC when EFTA members lower their external duties. Thus, the existence of important free trade areas greatly reduces the potential estimation bias associated wtih using the Buckler-Almon export elasticities. At the same time we retain the advantage of employing a detailed set of commodity elasticities.

Another instance in which the export prices of certain foreign exporters remain unchanged by multilateral tariff cuts relates to the tariff preferences (duty-free entry) already granted for certain products by the United States, Japan, and the EC to the developing nations. This also reduces the potential estimation bias associated with using the Buckler-Almon export elasticities.

Alternative approaches could have been followed in dealing with the export side of U.S. trade. One is to obtain import elasticities for each foreign country and then allocate on the basis of historical shares the import increase in a particular sector between the United States and all other suppliers. However, detailed commodity elasticities were not readily available for all of the countries included in this study. Consequently, utilizing the detailed Buckler-Almon export elasticities seemed preferable to alternative ways of estimating U.S. export effects in a multilateral trade negotiation.

Price Deflators

Given a set of import and export demand elasticities and the 1971 trade and tariff data from the GATT tape, it is possible to estimate changes in U.S. exports and imports as a result of a particular tariff-cutting rule. These changes are, however, expressed in terms of 1971 prices. Since the input-output table is based on 1967 data, the export and import changes must first be expressed in 1967 prices before total resultant changes in domestic output can be calculated. This is accomplished by deflating the trade changes classified on a 4-digit SIC basis by 1971 4-digit SIC unit values (where 1967 = 100) and then reclassifying the trade changes on the basis of input-output industry definitions. The 4-digit SIC unit values for manufactures were obtained from the Bureau of Economic Analysis, Department of Commerce. For nonmanufacturing industries, they were obtained partly from published Bureau of Labor Statistics sources and partly from work sheets at BLS.

Employment Coefficients

The next step in the analysis is to obtain employment effects of the changes in imports and exports. This is accomplished by first subtracting the appropriate international margins from exports to obtain exports on an f.o.b. basis and then deducting domestic trade and transportation margins from both f.o.b. exports and c.i.f. imports in order to obtain final demand shifts for each sector on a producer value basis. In assigning the margins to the appropriate trade and transportation sectors, it is assumed that exports are transported abroad by U.S. firms and imports to the United States by foreigners. The changes in final demand are next premultiplied by the inverse matrix of the input-output table to obtain the direct and indirect shifts in domestic output. These output shifts are then multiplied by a set of labor coefficients for the 367-sector table that were kindly supplied by Professor Clark Bullard of the University of Illinois. Some small modifications in his figures were made after consulting with BLS. These figures are average coefficients rather than marginal coefficients, which would be the appropriate ones to use. However, there is little information available on marginal coefficients and it is necessary to employ average figures. If short-run supply curves are, in fact, horizontal, there will be no difference between the two measures.

Skill Groups

Besides being interested in the total number of individuals displaced or absorbed by tariff cuts, policy makers are now also concerned with the skill composition of the affected workers. To provide this information a BLS tape was obtained that contained detailed data on occupations for 120 industries. (The BLS data are based on the 1970 Sample Census of Population). These data were then classified according to the 367 industries of the input-output table.[15] For the purpose of this study, 14 skill groups are distinguished: research and development workers; professional and technical workers (production related); professional and technical workers (other); managers and administrators (production related); managers and administrators (other); craftsmen; sales workers; clerical workers; operatives; laborers, except farm; service workers; farmers and farm managers; private household workers; and farm laborers and foremen.

Regional Distributions

The regional distribution of employment changes caused by a policy decision by the government is another matter of interest. For this purpose the distribution by state of the industries distinguished in the 85-sector input-output table was obtained from the 1970 Sample Census of Population. Thus, it is possible not only to determine the total change in employment by state that is associated with a particular tariff-cutting rule, but also the distribution of each state's employment change by the 14 skill groups.

Effects of Tariff Reduction on Trade and Employment

The first question investigated with the model and data described in parts 1 and 2 is: What are the trade and employment effects in the United States of a significant reduction in tariffs by this country and the other eighteen nations listed on the GATT tape? A uniform 50 percent cut in tariff rates by these countries is selected as an example of a significant tariff cut.

Aggregative Effects

Table 3 indicates the aggregate trade and employment impact of a multilateral 50 percent linear cut under the assumption that exchange rates remain fixed. Set 1 import and export demand elasticities were used in the calculations. In our judgement, these are the "best" elasticities to employ. Certain products have, however, been excluded from the tariff-cutting process. They are: U.S. exports to the European Community of agricultural items subject to variable levies by the EC, U.S. imports of agricultural products subject to quantitative import restrictions, all U.S. imports and exports of textile items covered by the new international textile agreement, and U.S. oil imports. All of these commodities are subject to nontariff trade barriers (NTBs) that operate independently of tariffs.[16] Cutting duties on these items will not increase imports. Furthermore, it is unlikely that the nontariff barriers protecting them will be reduced appreciably during the current negotiations. Consequently, if the objective is to estimate the economic effects of a substantial tariff-cutting exercise under the current negotiations, these items should be excluded.

Although the tariff-cutting exercise leads to changes in exports and imports on the order of almost $2 billion each, the net trade shift is a negligible +$4 million. As the figures in Table 4 show, the surplus is composed of a $425 million surplus with the eighteen industrial countries and a $421 million deficit that represents the "free ride" benefits to the rest of the world.[17] The overall

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[15] This, of course, involved assigning data for a given industry on the BLS tape to more than one industry in the 367-industry classification system.

[16] Although quotas on oil have been removed, they (or equivalent restrictions) are likely to be reimposed. The actual textile items covered are only those on which QR's under the new agreement are effective. The specific input-output sectors affected by the exclusions are: for textiles, 16.01–16.04, 17.01, 17.10, 18.01–18.04, 19.01–19.03; for oil, 8.00, 31.01; for agriculture, part of 2.06 (peanuts), part of 14.01 (frozen beef), 14.02, part of 14.03 (most cheese), 14.05, 14.06.

[17] The same bilateral breakdown as in Table 4 for the other four elasticity sets is given in Appendix Table A-1 of the full report of which this paper is a condensation.

Table 3

Effects on U.S. Trade and Employment of a 50 Percent Linear Tariff Reduction

Tariff Reduction	All Industries	Manufacturing*
Changes (millions of 1971 dollars)		
Exports	1,750	1,591
Imports	1,746	1,717
Net trade shift	+4	−126
Employment change (man-years)		
Export-related	136,000	116,400
Import-related	−151,200	−148,100
Net employment change	−15,200	−31,700

*Manufacturing effects refer to the effects in all sectors of tariff cuts on manufactures rather than to the effects only in manufacturing sectors.

Table 4

Net Trade Changes by Country from a 50 Percent Linear Tariff Cut (in millions of 1971 dollars)

Country	All Industries	Manufacturing
Australia	62	54
Austria	−3	−4
Canada	289	284
EC	221	149
Finland	0.2	−0.3
Japan	−141	−206
New Zealand	16	14
Norway	4	4
Sweden	−0.1	−0.4
Switzerland	−21	−21
18 Countries above	425	273
Rest of world	−421	−399
Net	4	−126

employment effect (−15,000 jobs) is also very small, especially in view of the fact that the cuts can be staged over a ten-year period. Estimates of the trade and employment effects of a 50 percent linear cut that is restricted to manufactures alone are somewhat larger (a $126 million trade deficit and loss of 32,000 jobs), but still very small in relation to aggregate exports and imports and to the total labor force in manufacturing.

One interesting aspect of the results is that the average labor coefficient for the reduced domestic output caused by the tariff cuts is higher than the average labor coefficient for the increase in export production. Consequently, employment declines even though the tariff reductions in all industries produce a slight surplus in the trade balance. However, the labor content of a representative bundle of *all* exports is still slightly higher than the labor content of a representative bundle of import-competing production.[18] In other words, although the average labor content of all exports is slightly higher than of all import-competing production, the particular set of domestic commodities protected by U.S. tariffs is more labor intensive than the set of U.S. goods that face foreign duties.

Demand Changes for Various Skill Groups

Within recent years there has been an increase in concern for the income-distribution impact of government policies. A full income-distribution model is beyond the scope of this study, but the initial impact on different labor groups can be estimated by breaking down the total trade-related changes in employment into employment changes by labor-skill categories. Table 5 lists these changes by 14 skill groups both for all industries and manufacturing alone, using elasticity set 1.[19]

The 50 percent cut increases the all-industry requirements for R & D workers by 0.13 percent of their labor force, production-related technical workers by 0.08 percent, farmers by 0.47 percent, and farm laborers by 0.45 percent. The demand for all other types of labor declines. The largest of the declines both absolutely and relatively is for operatives, i.e., semiskilled workers. The percentage drop for this category is 0.14 percent, whereas the decreases for nonfarm laborers and craftsmen are 0.08 percent and 0.05 percent, respectively. The percentage decline for all workers combined is 0.02 percent. Tariff reductions for manufactures alone produce essentially the same results except that the demand for farm employees does not increase. Thus, tariff reductions in all industries raise the demand for the services of highly educated technical workers and farmers, and lower the demand for skilled, semiskilled, and unskilled labor. This result is another indication that high levels of education and relatively abundant supplies of agricultural land serve as the basis for the comparative-advantage position of the United States.

Employment Changes by State

Another distribution question of interest to policy makers is the regional impact of any negotiation. Table 6

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[18] On the basis of 1971 trade (deflated to 1967 prices), 1967 labor coefficients, and the 1967 input-output table, the average labor coefficient of a representative export bundle is 89.5 man-years per million dollars, whereas the same coefficient for a representative import-competing bundle is 88.0 man-years per million dollars of output.

[19] The same skill-group changes for elasticity sets 3, 4, and 5 are given in Appendix Table A-2 of the full report.

Table 5

Change in Employment by Occupation Group for a 50 Percent Linear Tariff Cut under Set 1 Elasticities

	All Industries				Manufacturing			
Occupation	Export-Related	Import-Related (man-years)	Net	Net as Percent of Total Work Force	Export-Related	Import-Related (man-years)	Net	Net as Percent of Total Work Force
1. R & D	6318	4682	1636	0.14	6211	4652	1559	0.12
2. Professional & tech. (prod. related)	7399	5848	1551	0.08	7206	5807	1399	0.07
3. Professional & tech. (other)	3044	3197	−153	—	2883	3161	−278	—
4. Management & admin. (prod. related)	10291	12245	−1954	−0.03	9720	12135	2415	0.04
5. Management & admin. (other)	255	227	28	—	224	223	1	—
6. Craftsmen	19622	24244	−4622	−0.05	18821	24026	−5205	−0.06
7. Sales workers	5236	6659	−1423	−0.03	4827	6596	−1769	−0.04
8. Clerical workers	20095	22904	−2809	−0.02	19033	22707	−3674	−0.03
9. Operatives	36776	53092	-16316	−0.14	35589	52766	−17177	−0.15
10. Laborers, except farm	5717	8393	−2676	−0.08	5181	8259	−3078	−0.09
11. Service workers	4404	4841	−437	−0.01	4096	4785	−689	−0.01
12. Farmers, farm managers	9206	2475	6731	0.47	1289	1467	−178	−0.01
13. Private household workers	0	0	0	0	0	0	0	0
14. Farm laborers, foremen	7376	2011	5365	0.45	1050	1203	−153	−0.01

gives these results, again for elasticity set 1.[20] The tariff reductions bring about a net loss in employment in 34 of the 50 states. The net job loss is more than 1,000 in Illinois, Massachusetts, Michigan, New York, and Pennsylvania. The major gainers are California, Minnesota, and Texas. In relative terms, four New England states—Massachusetts, Maine, New Hampshire, and Rhode Island—suffer the most, whereas Kansas, Minnesota, North Dakota, and South Dakota gain the most. The changes are all very small, however.

Trade and Employment Effects by Industry

Not only must policy makers be concerned with the macroeconomic pressures resulting from a multilateral trade negotiation, but they must be aware of its possible effects on individual industries. Negligible overall effects are no guarantee that individual industries will not suffer from sharp declines in employment and output. Table 7 indicates all those industries in which employment would either decrease or increase by at least ½ of 1 percent under a 50 percent cut if elasticity sets 1, 2, or 3 are utilized.[21] On the basis of this arbitrary criterion of ½ of 1 percent or more employment change, there are 54 import-sensitive and 19 export-sensitive industries that appear at least once when these three elasticity sets are employed. The employment change for the import-sensitive industries is 48,429 and for the export-oriented industries, 33,952.

In considering whether to phase cuts in import-sensitive industries over the full ten years permitted by the Trade Act of 1974, an initial consideration might be whether the annual growth rate for labor in ah industry more than offsets the labor force decline associated with a ten-year phasing arrangement. If it did, there would seem to be no reason for not reducing duties in the industry by the full 50 percent. If average growth rates for labor that prevailed from 1958 to 1971 are representative of the next ten years, the growth factor eliminates unemployment problems caused by the tariff reductions in 33 of the 54 import-sensitive industries.

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[20] Employment changes by state and skill group are reported in Appendix Table A-3 of the full report.

[21] Employment changes for each of the 367 industries and for the five elasticity sets are listed in Appendix Table A-4, and the ratios of the net employment changes to total industry employment are given in Table A-5 of the full report.

Table 6

Changes in Employment by State for a 50 Percent Linear Tariff Cut (man-years)

State	All Industries			Manufacturing		
	Export-Related	Import-Related	Net	Export-Related	Import-Related	Net
Alabama	1,749	−2,135	−386	1,411	−2,085	−674
Alaska	100	−114	−14	85	−110	−25
Arizona	1,186	−1,062	124	1,032	−1,003	29
Arkansas	1,275	−1,493	−218	877	−1,437	−560
California	14,420	−13,551	869	12,767	−13,301	−534
Colorado	1,328	−1,394	−66	1,065	−1,345	−280
Connecticut	3,202	−2,974	228	3,066	−2,952	114
Delaware	435	−462	−27	395	−456	−61
D.C.	206	−242	−36	187	−239	−52
Florida	3,464	−3,642	−178	2,824	−3,546	−722
Georgia	2,456	−2,905	−449	1,949	−2,830	−881
Hawaii	289	−298	−9	205	−286	−81
Idaho	466	−423	43	259	−386	−127
Illinois	8,343	−9,710	−1,367	7,448	−9,574	−2,126
Indiana	4,219	−5,035	−816	3,755	−4,967	−1,212
Iowa	1,947	−1,698	249	1,183	−1,595	−412
Kansas	1,516	−1,236	280	1,094	−1,179	−85
Kentucky	1,925	−1,993	−68	1,480	−1,931	−451
Louisiana	1,543	−1,600	−57	1,211	−1,550	−339
Maine	601	−1,392	−791	493	−1,376	−883
Maryland	2,006	−2,549	−543	1,804	−2,517	−713
Massachusetts	4,669	−6,169	−1,500	4,446	−6,131	−1,685
Michigan	5,307	−6,559	−1,252	4,788	−6,464	−1,676
Minnesota	3,277	−2,703	574	2,609	−2,584	25
Mississippi	1,212	−1,291	−79	783	−1,233	−450
Missouri	3,000	−3,758	−758	2,391	−3,663	−1,272
Montana	412	−361	51	223	−328	−105
Nebraska	1,011	−813	198	569	−754	−185
Nevada	186	−223	−37	155	−211	−56
New Hampshire	592	−1,080	−488	555	−1,074	−519
New Jersey	5,344	−6,250	−906	5,045	−6,199	−1,154
New Mexico	403	−430	−27	312	−404	−92
New York	12,257	−13,902	−1,645	11,376	−13,754	−2,378
North Carolina	2,971	−3,421	−450	2,162	−3,310	−1,148
North Dakota	415	−234	181	154	−200	−46
Ohio	8,736	−10,441	−1,705	8,082	−10,338	−2,256
Oklahoma	1,339	−1,302	37	1,022	−1,257	−235
Oregon	1,353	−1,464	−111	1,011	−1,415	−404
Pennsylvania	8,597	−11,063	−2,466	7,957	−10,955	−2,998
Rhode Island	698	−1,282	−584	669	−1,277	−608
South Carolina	1,449	−1,645	−196	1,179	−1,607	−428
South Dakota	459	−290	169	198	−252	−54
Tennessee	2,401	−3,165	−764	1,976	−3,102	−1,126
Texas	6,587	−6,111	476	5,309	−5,927	−618
Utah	567	−599	−32	466	−569	−103
Vermont	390	−339	51	326	−330	−4
Virginia	2,317	−2,766	−449	1,932	−2,708	−776
Washington	2,487	−2,217	270	2,067	−2,155	−88
West Virginia	933	−1,159	−226	827	−1,143	−316
Wisconsin	3,512	−3,729	−217	2,860	−3,637	−777
Wyoming	177	−156	21	103	−140	−37

Table 7

Changes in Employment in Selected Industries for a 50 Percent Linear Tariff Cut

A. Industries Losing 0.5 Percent or More of Their Labor Force

I-O No.	Industry	Loss in Employment (man-years)*	Percentage of Industry's 1967 Labor Force†	Annual Average Labor Growth Rate 1958–71‡
5.00	Iron, ferroalloy mining	173	0.63	—
6.02	Other nonferrous mining	281	1.03	—
13.05	Small arms	71	0.51	5.9
14.19	Sugar	421	1.23	−0.8
14.26	Vegetable oil mills	19	1.06	−2.8
16.04	Thread mills	80	0.67	−0.8
17.03	Lace goods	111	2.09	−3.9
17.07	Tire cord, fabric	54	0.51	−1.7
17.08	Scour, combing plants	242	4.57	−3.2
17.09	Cordage and twine	56	0.52	−2.6
20.06	Veneer and plywood	1,330	1.70	1.0
20.09	Wood products	463	0.61	4.9
23.07	Furniture, fixtures	1,663	14.59§	2.3
28.02	Synthetic rubber	79	0.53	2.1
32.01	Tires and inner tubes	489	0.53	1.2
32.02	Rubber footwear	3,838	13.14	2.8
32.04	Miscellaneous plastic products	1,469	0.58	2.3
33.00	Industrial leather tanning	1,021	3.09	−5.2
34.01	Footwear cut stock	78	0.53	−3.7
34.02	Footwear, nonrubber	6,104	2.67	−1.9
34.03	Other leather products	3,046	3.98	−0.5
35.01	Glass products, no containers	854	0.82	−0.4
36.03	Ceramic wall, floortile	310	2.70	−3.8
36.07	Food utensils, pottery	2,883	20.59	−2.1
36.08	Porcelain electrical supply	123	0.84	1.7
36.09	Pottery products	832	9.67	0.6
36.22	Nonmetal mineral products	36	0.62	0.7
37.01	Furnaces, steel products	4,080	0.65	0.3
38.02	Primary lead	40	1.33	−0.2
38.03	Primary zinc	102	1.15	−1.7
38.04	Primary aluminum	104	0.54	2.6
38.05	Primary nonferrous metals	52	0.66	8.6
42.01	Cutlery	297	2.36	0.3
42.11	Fabricated metal products	36	0.79	6.2
46.01	Elevator, moving stairs	103	0.72	4.3
48.02	Textile machinery	741	1.86	−0.5
54.06	Sewing machines	171	2.59	−3.8
54.07	Household appliances	72	0.52	0.1
55.02	Lighting fixtures	521	0.62	2.8
56.01	Radio, TV sets	2,979	2.51	2.3
57.01	Electronic tubes	858	1.36	−8.2
58.05	Electrical equipment	206	1.42	2.8
61.06	Motorcycle, bicycle parts	1,487	11.99	4.6
62.07	Watches, clocks, parts	1,018	2.45	1.6
63.01	Optical instruments, lenses	434	1.90	5.9
63.02	Ophthalmic goods	238	0.85	3.4
64.01	Jewelry	2,772	2.69	2.0
64.02	Musical instruments, parts	444	1.91	1.8
64.03	Games, toys	1,598	3.10	1.5
64.04	Sport, athletic goods	1,063	2.51	1.6
64.06	Artificial flowers	552	11.27	−5.2
64.07	Buttons, needles, pins and fasteners	501	2.23	6.6
64.08	Brooms and brushes	86	0.53	0.1
64.12	Miscellaneous manufactures	1,4[illegible]2	1.64	1.9
	Total	48,429		

Table 7 (continued)

B. Industries Gaining 0.5 Percent or More of Their Labor Force

I-O No.	Industry	Gain in Employment (man-years)‖	Percentage of Industry's 1967 Labor Force**
2.03	Tobacco	10,229	3.05
14.10	Dehydrated food products	65	0.53
24.01	Pulp mills	161	0.94
24.03	Paperboard mills	750	0.98
28.01	Plastic material, resins	789	0.94
45.03	Oil field machinery	186	0.57
51.01	Computing machines	5,826	3.22
51.02	Typewriters	224	0.79
51.04	Office machines	526	2.34
53.01	Electrical measuring instruments	582	0.87
53.05	Industrial controls	337	0.61
53.08	Electrical industrial apparatus	98	0.50
57.02	Semiconductors	5,138	6.30
57.03	Electronic components	3,242	1.35
58.03	X-ray apparatus, tubes	92	1.10
60.01	Aircraft	2,903	0.72
60.04	Aircraft equipment	1,223	0.53
62.01	Engineering, science instruments	305	0.56
62.02	Mechanical measuring device	1,276	1.48
	Total	33,952	

*The largest absolute loss under three elasticity sets is reported.

†The largest percentage loss under the three elasticity sets is reported.

‡Source: U.S. Department of Commerce, *Annual Survey of Manufactures, 1971: Industry Profiles*, U.S. Government Printing Office, 1973.

§The classifications of U.S. imports of furniture do not adequately distinguish furniture by type of material or by use; hence in concording TSUS numbers to SIC and I-O industries, all furniture arbitrarily is assigned to I-O 23.07, Furniture and fixtures, n.e.c. It follows that in calculating the percentage domestic output or employment changes that result from tariff cuts, it would be better to consider all furniture sectors of the I-O table as a single industry. When this is done, the percentage loss is 0.51.

‖The largest absolute gain under the three elasticity sets is reported.

**The largest percentage gain under the three elasticity sets is reported.

The remaining 21 industries that cannot cope with their unemployment problem through growth are indicated in the table by boldface numbers.

Even in these latter industries, voluntary quits can relieve much of the pressure to lay off workers on an involuntary basis. Reducing duties less than the general rule or perhaps in a few cases excepting the item completely from duty cuts can prevent most remaining pressures for involuntary unemployment. In other words, even if one adopts the very pro-labor position that tariff cuts should not cause any involuntary unemployment—a position that ignores the consumer and growth benefits of tariff reductions—it appears that the number of industries in which tariffs should be cut less than the general average is quite small.

Sensitivity of Aggregative Changes to Elasticity Assumptions

The next step in the analysis is to investigate the sensitivity of the preceding results to variations in import and export demand elasticities. To do this, four sets of elasticities in addition to set 1 are employed. As noted in part 2, set 2 is the same as set 1 except that import elasticities estimated by the International Trade Commission for 15 input-output sectors are substituted for the import elasticities employed in set 1 for these 15 sectors.[22] Set 3 utilizes Stern's summary of "best" elasticities as enumerated in Table 2. Set 4 combines the

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[22] The values for these elasticities are given in footnote 14.

"high" export demand elasticities and "low" import demand elasticities and set 5 combines the "low" export demand and "high" import demand elasticities listed in Table 2.

Table 8 gives the results of the 50 percent cut under these various elasticities assumptions. As the table indicates, sets 2 and 4 give higher figures for the trade surplus than set 1 does and also yield net increases in employment. Sets 3 and 5, on the other hand, yield net deficits and net decreases in employment. The employment decline under set 3 (Stern's "best" elasticities) is still small, but the 266,000 job loss that occurs if import demands are highly elastic and export demands are characterized by low elasticities must be regarded as significant. Generally, similar conclusions hold for manufacturing alone as for all industries. Thus, there is an outside possibility that import demand elasticities are so high relative to export demand elasticities that considerable unemployment would result from a one-step 50 percent multilateral tariff cut, if exchange rates were fixed. However, the most probable range for these elasticity values yields overall trade and employment changes small enough that a significant tariff-cutting exercise cannot reasonably be opposed on balance-of-trade or aggregate employment grounds, especially when it is remembered that the cuts can be staged over a ten-year period.

Exchange Rate Changes

If exchange rates are flexible, the net deficits and surpluses reported in previous tables will not in fact emerge. Instead, as these pressures begin to operate in response to the tariff cuts, exchange rates will change to restore equilibrium.[23] Table 9 indicates the exchange rate shifts needed to restore equilibrium as well as the net changes in employment after the deficit or surplus pressures have been eliminated. The required exchange-rate changes are very small except under elasticity sets 4 and 5. As would be expected, the net employment effect when both tariffs and exchange rates are changed is small even in those instances where the trade effect is large in the absence of exchange-rate shifts. The existence of exchange rate flexibility thus acts as a powerful adjustment assistance program that prevents any significant adverse impact on labor as a whole.

Cutting Duties on NTB Items

A final exercise at the aggregative level involved converting the various nontariff trade distortions on the excluded items into their ad valorem tariff equivalents and then estimating trade and employment effects by cutting these tariff equivalents by 50 percent. As noted in part 2, Larry Wipf of the Office of Foreign Economic Research, Department of Labor, calculated ad valorem equivalents for the European Community's variable

Table 8

Aggregate U.S. Trade and Employment Effects of a 50 Percent Tariff Cut under Various Trade Elasticities without Exchange-Rate Changes

	Elasticities				
	Set 1	Set 2	Set 3	Set 4	Set 5
All Industries					
Change (millions of 1971 dollars)					
Export (ΔX)	1,750	1,750	877	1,900	394
Import (ΔM)	1,746	1,589	1,187	407	3,327
$\Delta X - \Delta M$	4	161	−310	1,493	−2,932
Employment change (man-years)					
From ΔX	136,000	136,000	64,000	140,100	28,700
From ΔM	−151,200	−135,100	−101,300	−26,800	−295,100
Net employment change	−15,200	900	−37,300	113,300	−266,400
Manufacturing					
ΔX	1,591	1,591	809	1,721	365
ΔM	1,717	1,560	1,153	393	3,189
$\Delta X - \Delta M$	−126	31	−343	1,328	−2,834
Employment change from ΔX	116,400	116,400	55,800	118,800	25,200
Employment change from ΔM	−148,100	−132,000	−96,700	−25,700	−276,400
Net employment change	−31,700	−15,600	−40,900	93,100	−251,200

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[23] In determining required exchange rate changes, it is assumed that the dollar appreciates or depreciates the same percentage against all foreign currencies. With a multilateral negotiation and flexible rates for all participants, one would need to know all the pair-wise trade balances to determine the change in the value of the dollar vis a vis every other currency.

Table 9

Aggregate U.S. Trade and Employment Effects of a 50 Percent Tariff Cut under Various Trade Elasticities with Exchange-Rate Changes

	Elasticities				
	Set 1	Set 2	Set 3	Set 4	Set 5
All Industries					
Change (millions of 1971 dollars)					
Export (ΔX)	1,747	1,612	1,179	−465	877
Import (ΔM)	1,747	1,612	1,179	−465	877
$\Delta X - \Delta M$	0	0	0	0	0
Employment change (man-years)					
From ΔX	135,800	123,300	90,200	−66,400	70,700
From ΔM	−151,200	−137,000	−101,500	+48,600	−98,800
Net employment change	−15,400	−13,700	−11,300	−17,800	−28,100
Exchange rate change (percent)	+0.003	+0.166	−0.688	+2.43	−2.46
Manufacturing					
ΔX	1,695	1,564	1,143	−386	832
ΔM	1,695	1,564	1,143	−386	832
$\Delta X - \Delta M$	0	0	0	0	0
Employment change from ΔX	126,600	114,000	84,800	−65,200	65,700
Employment change from ΔM	−146,200	−132,400	−96,900	+41,100	−85,900
Net employment change	−20,200	−18,400	−12,100	−24,100	−20,200
Exchange rate change (percent)	−0.126	+0.032	−0.761	+2.17	−2.38

levy items as well as for those U.S. imports of agricultural products that are subject to quantitative restrictions. Using Mintz's study on the effects of quotas, duties on textiles and apparel were adjusted so that the quantitative controls have the effect of raising prices by 5 percent over existing levels [6, p. 62]. No adjustment was made in the duty on imported oil.

Table 10 indicates the trade and employment effects from a 50 percent linear cut on the NTB items, assuming a fixed exchange rate. Cutting protective levels on agricultural items improves the U.S. trade balance significantly under all elasticity sets. However, except under set 4 elasticities, the increase in textile imports, when quantitative restrictions on these items are reduced, more than offsets the surplus-creating impact of cutting levels of foreign protection on agricultural items. Except when set 4 elasticities are utilized, there also is a fairly large net decline in employment when the protective levels of nontariff barriers are reduced by 50 percent.

Literature Cited

1. Baldwin, Robert E., and Gerald M. Lage. "A Multilateral Model of Trade-Balancing Tariff Concessions." *Review of Economics and Statistics*, 52 (August 1971), 237–45.
2. Buckler, Margaret, and Clopper Almon. "Imports and Exports in an Input-Output Model." *Proceedings of the Business and Economics Section of the American Statistical Association* (1972), 175–84.
3. Clark, Peter. "The Effects of Recent Exchange Rate Changes on U.S. Trade Balance." In *The Effects of Exchange Rate Adjustments*, edited by P. Clark, D. Logue and R. Sweeney, Washington, D.C.: Government Printing Office, 1977.
4. Magee, Stephen P. "Prices, Incomes, and Foreign Trade." In *International Trade and Finance: Frontiers for Research*, edited by P. B. Kenen. Cambridge: Cambridge University Press, 1975.
5. ______. "The Welfare Effects of Restrictions on U.S. Trade." *Brookings Papers on Economic Activity*, 3 (1972), 645–97.
6. Mintz, Ilse. *U.S. Import Quotas: Costs and Consequences*. Washington, D.C.: American Enterprise Institute, 1972.
7. Mutti, John H. "The Employment and Welfare Effects of Foreign Trade Policy." Ph.D. thesis, University of Wisconsin, 1974.
8. Richardson, J. David. "Estimating Demand and Supply Parameters without Import Prices: Methodology and Empirical Results." *Proceedings of the Business and Economics Section of the American Statistical Association* (1973), 132–41.
9. ______. "The Response of Imports and Domestic Demand to Price, Tariff and Exchange Rate Changes: A Structural Estimation Study for Selected Manufactures." Mimeographed. Washington, D.C.: Department of State, Bureau of Economic Affairs, 1972.
10. Stern, Robert M. *Price Elasticities in International Trade: An Annotated Bibliography*. London: Trade Policy Research Centre, 1976.
11. United Nations. *Standard International Trade Classification, Revised*. New York: United Nations, 1961.

12. U.S. Department of Commerce, Bureau of the Census. *U.S. Foreign Trade Statistics: Classifications and Cross-Classifications, 1970*. Washington, D.C.: Government Printing Office, 1971.

13. U.S. Department of Commerce, Bureau of Economic Analysis. *Input-Output Structure of the U.S. Economy: 1967*. Washington, D.C.: Government Printing Office, 1974.

14. Walters, Alan A. "Production and Cost Functions: An Econometric Survey." *Econometrica*, 31 (January-April 1963), 1–66.

Table 10

Effects on U.S. Trade and Employment, by Commodity Group, of Reducing Tariff Equivalents of NTBs by 50 Percent

	Agricultural Goods	Textiles, Including Apparel	Oil, Crude & Refined	All Other†	Total
Set 1 (and Set 2) Elasticities*					
Change (millions of 1971 dollars)					
Exports (ΔX)	385.2	48.5	0	0	433.7
Imports (ΔM)	65.2	1,012.3	79.6	−12.7	1,144.4
$\Delta X - \Delta M$	+320.0	−963.8	−79.6	+12.7	−710.7
Employment change (man-years)					
From ΔX	12,679	3,143	320.0	16,805	32,947
From ΔM	−11,545	−91,636	−1,653	−36,609	−141,443
Net employment change	+1,134	−88,493	−1,333	−19,804	−108,496
Set 3 Elasticities					
Change (millions of 1971 dollars)					
Exports (ΔX)	152.8	40.0	0	0	192.8
Imports (ΔM)	44.8	604.5	70.3	−9.8	709.8
$\Delta X - \Delta M$	+108.0	−564.5	−70.3	+9.8	−517.0
Employment change (man-years)					
From ΔX	5,207	2,480	134	7,263	15,084
From ΔM	−8,312	−52,290	1,369	−23,550	−85,521
Net employment change	−3,105	−49,810	−1,235	−16,287	−70,437
Set 4 Elasticities					
Change (millions of 1971 dollars)					
Exports (ΔX)	384.2	84.4	0	0	468.6
Imports (ΔM)	17.1	161.5	35.9	3.3	217.8
$\Delta X - \Delta M$	+367.1	−77.1	−35.9	−3.3	+250.8
Employment change (man-years)					
From ΔX	13,054	5,257	329	17,690	36,330
From ΔM	−2,209	−13,946	−680	−7,021	−23,474
Net employment change	+10,845	−8,689	−351	10,669	+12,856
Set 5 Elasticities					
Change (millions of 1971 dollars)					
Exports (ΔX)	67.8	18.0	0	0	85.7
Imports (ΔM)	191.2	1,678.8	132.7	−34.0	1,968.7
$\Delta X - \Delta M$	−123.4	−1660.8	−132.7	+34.0	−1,882.0
Employment change (man-years)					
From ΔX	2,301	1,120	60	3,236	6,717
From ΔM	−27,298	−145,697	−2,682	−66,670	−242,347
Net employment change	−24,997	−144,577	−2,622	−63,434	−235,631

Note: The input-output sectors covered by the NTBs are 1-4, 8, 14, 16-19, and 31.01. Within sectors 16-19 NTBs are reduced only on sectors 16.01-16.04, 17.01, 17.10, 18.01-18.04, 19.01-19.03.

*For the sectors covered by the NTBs, set 1 and 2 elasticities are the same.

†Indicates the intermediate inputs (other than of agricultural goods, textiles, and oil) associated with import and export changes in the other three sectors and thus the import change can be positive or negative.

Comment

Harry G. Johnson

Baldwin and Lewis are to be congratulated on a very thorough and carefully thought out study, probably the most professionally satisfactory study yet carried out on the subject. My comments are therefore directed, not in criticism of this particular study, but at certain characteristics and assumptions of the tradition of work in this field. Before entering into them, however, I should state explicitly that I support their choice of the perfectly substitutable supply, imperfectly substitutable demand, assumption (especially if, as they intend, they modify it in later work by making a different assumption for agriculture and mineral deposits). In fact, there is an additional justification for this assumption, in my view, in that perfect substitutability in demand would probably give rise to serious difficulties of estimation in a situation in which foreign demanders impose different tariffs on imports and these are altered by different amounts following negotiation of a standard percentage of tariff rate reduction. (In particular, emphasis would have to shift from demand to supply elasticities—to whose estimation much less professional effort has been directed.)

My first, not major, criticism relates to the assumption explained in detail in their paper, that an increase in expenditure on imports net of tariffs is matched by an equal decrease in expenditure on domestic goods. This has the advantage of simplifying the calculations greatly, and can be justified as applied to a general tariff reduction in which cross-effects "will come out in the wash"; but it does impose restrictions on cross-effects on import and export demand that might be important in getting from the impact effect to the multiplier or exchange-rate adjustment. Second, the analysis seems to use one term only to represent real income as a constraint on total demand. Macroeconomically, however, a country's expenditure or absorption need not equal its output or production, the difference being constituted by capital movements including reserve movements. Theoretically, the savings or dissavings implied should enter into the demand and supply functions posited, rather than being left to be determined residually by the effects of relative price changes resulting from trade liberalization on trade volumes, deduced from what essentially reduce to microeconomic elasticities.

This brings me to a third point: the results of the empirical estimations that are given most emphasis in the paper, the effects of trade liberalization on trade volumes and employment, are "impact effects" only. Specifically, they involve a change in the balance between exports and imports, that is, a change in the relation between absorption and output or aggregate production and aggregate consumption, which cannot be taken to be an equilibrium position except on a very peculiar set of assumptions about aggregate demand, saving, and reserve or cash accumulation or decumulation, which cannot be accepted as realistic [2].

To complete the calculation and arrive at results consistent with full equilibrium, there are two possibilities open. The first, obvious, and necessarily consistent one is to calculate the exchange rate change necessary to restore equilibrium — a change that would occur automatically under the present system of floating exchange rates, particularly given the relatively small depreciation of the dollar indicated as required by the estimates produced by the study. It may be noted in passing that such an equilibrating depreciation of the dollar should not be interpreted as necessarily entailing a welfare loss for the United States. (A calculation of the welfare effects of trade liberalization is not provided in the paper, though I understand the larger study envisages some detailed calculations along these lines.) The reason why a terms-of-trade loss implicit in a depreciation is not necessarily a welfare loss is that the liberalization of trade itself involves a welfare gain. Nevertheless, previous studies, notably that of Basevi [1], confirm the general expectation that, with the low elasticities suggested by empirical estimates, the United States is likely to lose more on the terms of trade than it gains from trade liberalization.

The second alternative is suggested by foreign trade multiplier theory, the initial excess supply in the United States evoking a multiplier reduction in U.S. income and employment (and converse expansion elsewhere) leading to a new equilibrium with a lower U.S. trade deficit than the impact deficit, but still a deficit associated with a reduction in U.S. and an increase in foreign net international saving (or, more accurately, "hoarding" or accumulation of international reserves). The authors suggest that the necessary calculations can easily be made on the usual assumption that the monetary authorities maintain a fixed level of interest rates. On the contrary, in principle the maintenance of fixed interest rates in face of a balance-of-payments deficit involves a continuing process of replacing an outflow of international reserve by open-market purchases of domestic securities; and this is a process that cannot be assumed for most countries to be able to go on forever [3, 4]. In the case of the United States in relation to the rest of the world, however, given the very small trade loss emerging from the calculations, and the still smaller loss that would appear after the multiplier calculations had been made, together with the international role of the dollar as a reserve currency, the assumption would probably be tolerable as an approximation.

The foregoing relates to the effects on trade. The authors are, however, particularly concerned with employment, which, on their input-output calculations, they find will decrease even if trade is kept balanced by an appropriate (small) depreciation of the dollar. This finding, however, leaves a loose end, which is the subject of my fourth comment. Presumably, less labor per unit of value added is accompanied or balanced by more capital per unit of value added, on the tautological principle that all value added has to be added by something (either labor or nonlabor inputs), and the question is where in the economy the nonlabor sources of value added, needed to keep value added in exporting equal to value added in importing, are to come from. In other words, in addition to the exchange rate adjustment necessary to keep value added constant, the calculation should include an adjustment of the price of labor relative to capital necessary to keep employment of labor and "capital" (nonlabor value added) constant. To be strictly accurate, the calculation should include changes in two relative prices or three numeraire prices, to maintain full employment of the two factors of production and therefore, implicitly, full-employment production and balanced international trade.

My fifth comment concerns the use of a (modified) 50 percent reciprocal tariff cut as the standard case of reciprocal trade liberalization for analysis. Most of the argument relating to the computation effect is devoted to discussion of the elasticities selected; and on this score one can only accept the authors' judicious discussion of and selection among alternatives. It is clear from the nature of the calculations, however, that apart from the elasticities employed, the outcome will depend, perhaps significantly and substantially, on two "structural" magnitudes, the tariff rates now in force, to which the linear 50 percent tariff cuts will apply, and the relative volumes of exports and imports of the trade-liberalizing countries. It is also apparent from the statistics presented that the United States has a lower average tariff rate on manufactured goods than have its major trading partners, and that the United States exports in larger volume to than it imports from other countries. On both grounds, a 50 percent tariff reduction applied by all major countries might well be assumed a priori automatically to favor the United States as compared with the others, leading them (especially the Common Market countries) to argue, as they did in the early stages of the Kennedy Round, for some different principle of reciprocal tariff reduction. In this connection, it would seem that, rather than accept the (modified) 50 percent tariff-cutting rule as obviously fair and then calculating its actual effects, the study's results should be used explicitly to show that, despite superficial arguments to the contrary, the 50 percent principle leaves the United States (for reasons related to the interaction of differences in elasticities with dispersion of tariff rates about their averages) at a significant if relatively small disadvantage as compared with a formula producing exactly equal expansion of its trade in both directions. Alternative principles of negotiation are, of course, discussed in William Cline's paper for this conference.

My sixth and final comment relates to the discussion of adverse effects of trade liberalization on U.S. employment in the aggregate and by state and industry. It seems to me completely arbitrary to set 0.50 percent as a standard defining negligible effects on employment, especially over a ten-year adjustment period starting in 1980, or to study whether the adverse effect will be absorbed by employment growth in the industry concerned over the adjustment period. It would seem more economically relevant to relate employment displacement by increased import competition to the natural wastage of existing employees through retirements and voluntary quits. In a reasonably fully employed economy, which one hopes will be the normal situation by 1980, the earliest date at which trade liberalization is likely to start, adjustments of employment to trade liberalization are likely to be negligible in relation to everyday labor market adjustment, as expressed in new entries, retirements, and voluntary job changes. The real problem of employment adjustment per se is likely to be, typically, the problem of a senior group of relatively unskilled but well-paid workers, whose traditional employment is threatened by rapid increases of imports from the lower-paid and frequently more skilled workers in other developed countries or developing countries. Such a problem would be infrequent enough, and manageable enough by policy (including temporary slowing of import growth), not to need to pose a serious obstacle to trade liberalization. Unfortunately, this problem tends to be compounded and confounded with the much more serious problem of abnormally low aggregate demand resulting from restrictive fiscal-monetary policy and antidepreciation exchange rate policy, the effect of which in creating unemployment is most easily blamed, inaccurately, on unfair foreign competition and used to support demands for increased barriers against imports.

Literature Cited

1. Basevi, Giorgio. "The Restrictive Effect of the U.S. Tariff and Its Welfare Value." *The American Economic Review*, 58 (September 1968), 840–52.
2. Dornbusch, Rudiger. "Devaluation, Money, and Non-Traded Goods." *The American Economic Review* (December 1973), 871–80.
3. Frenkel, Jacob A., and Harry G. Johnson, eds. *The Monetary Approach to the Balance of Payments*. London: George Allen and Unwin; Toronto: University of Toronto Press, 1976.
4. Johnson, Harry G. "Elasticity, Absorption, Keynesian Multiplier, Keynesian Policy, and Monetary Approaches to the Devaluation Theory: A Simple Geometrical Exposition." *The American Economic Review*, 66 (June 1976), 448–52.

Reply

Robert E. Baldwin and Wayne E. Lewis

Harry Johnson rightly emphasizes some of the limitations of an analysis such as ours. He points out, for example, that our first estimates of the trade and employment effects of general tariff cuts are initial "impact effects." To determine the total effect of the cuts, the secondary trade and employment consequences of these "impact effects" must be calculated. In a world of flexible exchange rates this involves estimating the exchange rate movement needed to eliminate the disequilibrating impact of the tariff reductions and then determining the net employment change associated with the tariff and exchange rate changes. This is the approach we have followed. With fixed exchange rates it is necessary to calculate the multiplier effects of the initial shifts in foreign trade and then the net trade and employment changes due to the tariff cuts and these multiplier effects. As Johnson points out, even these calculations do not give a long-run equilibrium, since trade balance will generally not be completely restored by the multiplier process and there would be an indefinite inflow or outflow of international reserves. We chose not to calculate either the multiplier effects or explore the longer run implications of continuing changes in international reserves. The $4 million "impact effect" of the 50 percent cuts seemed too insignificant to warrant such calculations, and, moreover, we were primarily concerned with the present system of flexible rates.

Johnson's point with respect to the change in value added by capital in the adjustment process is well taken. When the exchange rate changes in response to the tariff cuts and trade-balance at a higher level is restored with a net decrease in employment, changes in capital utilization are occurring in the background. In a full employment world a change in the price of labor relative to capital would take place and in turn affect labor and capital utilization. Instead of following this interesting line of analysis we have implicitly assumed less than full employment of both labor and capital and fixed relative prices of these factors. In a continuing study of tariff-cutting effects J. David Richardson and I are beginning to explore the welfare and distributional consequences of tariff cuts on capital.

The model is being used to test the "impact effects" on trade and employment of different tariff cutting formulas being proposed in the current Tokyo Round of trade negotiations in Geneva. The 50 percent rule is used in the paper only for illustrative purposes, and the effects of various harmonization rules are presented in my larger study. An appendix to this latter study gives the trade and employment changes in all industries and enables one to decide for himself what a reasonable cutoff figure would be for presenting summary tables. More important, in our continuing study we have utilized a Labor Department study of the length of unemployment of workers displaced by imports, depending upon their economic characteristics, to calculate the real income change associated with the employment shifts due to tariff cuts. These welfare effects together with those affecting other factors will be combined with the consumer benefits of tariff reductions to derive the total welfare change.

Multilateral Effects of Tariff Negotiations In the Tokyo Round

William R. Cline, Noboru Kawanabe, T.O.M. Kronsjo, and Thomas Williams[*]

1. Introduction

This study presents a model of the tariff negotiations developed in a broader study (the Brookings Trade Study referred to in this paper) of multilateral trade negotiations in the Tokyo Round [8]. Section 2 sets forth the model itself; section 3 reports the estimates of trade, welfare, and exchange rate effects of alternative tariff-cutting formulas; section 4 discusses corresponding estimates of employment effects. The concluding section draws policy implications and in addition summarizes our findings on nontariff barriers in the broader study.

Tariffs remain a significant barrier to trade despite the success of earlier negotiations, especially the Kennedy Round in the mid-1960s. For the major industrial countries tariffs on manufactures stand at an average of 11 percent, and tariffs on nonagricultural raw material average 5.7 percent for dutiable items [11]. Much higher tariffs exist on individual products; moreover, the escalation of tariffs as the stage of processing rises causes the effective rate of protection on value added to be substantially higher than nominal protection for manufactured goods.

The reduction of tariffs and nontariff barriers should make possible increased efficiency in world production patterns. Yet little progress was made toward liberalization in the first two years of active negotiations following the passage of the U.S. Trade Act in January 1975. American negotiators proposed tariff-cutting formulas that would cut most tariffs by close to 60 percent; the EEC proposed a harmonization approach (in which lower tariffs are cut by lower proportions) yielding much more modest liberalization; and the Japanese subsequently proposed another relatively restrictive formula (as discussed below). The possibility of agreement on tariff liberalization in this period suffered from opposing views between the United States and the EEC in the area of agricultural products, and the atmosphere of impasse in this field spread to other areas of the negotiations.

This study seeks to quantify the economic stakes in the Tokyo Round, by estimating effects that could be expected under alternative outcomes of the negotiations. The empirical results should facilitate policy assessments by governments and by legislatures and the public concerned about the implications of the agreements eventually achieved.

2. A Model of Tariff Negotiations

The basic calculations of the model examine the effects of reducing tariffs, with computations at the "tariff line" that are then added up to sector or global levels. The harmonization tariff-cutting approaches can only be evaluated accurately at the tariff line level (even though tens of thousands of categories, and millions of pieces of data on trade flows are required) because the use of average tariffs over aggregated categories will seriously bias estimates when the percent cut in tariff differs by height of tariff.

Increased imports in reponse to lowered tariffs are calculated by applying empirically estimated "import elasticities" (percent change in imports per unit percent change in import price) to the base level of imports and the percentage change in consumer price caused by a particular tariff cut. Increased exports are calculated by summing up over other countries their increased imports from the supplier in question.

For both world supply of imports and home country exports we assume a horizontal supply curve. Completely elastic supply is the reasonable assumption in view of the extremely small trade changes relative to output, especially considering the fact the even these small changes would be phased in over a period of five or more years.[1]

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[*] This paper is based on William R. Cline, Noboru Kawanabe, T.O.M. Kronsjo, and Thomas Williams' "Trade, Welfare, and Employment Effects of Multilateral Trade Negotiations in the Tokyo Round" which was completed in 1976 under ILAB contract 75-7 at the Brookings Institution. The study will be published as *Trade Negotiations in the Tokyo Round: A Quantitative Assessment*. Washington, D.C.: Brookings Institution, 1978.

Given estimates of trade and tariff changes, static welfare gains from liberalization are calculated using the traditional "triangle" method (which measures savings to consumers and savings from reducing inefficient domestic production). We attempt to examine the magnitude of total welfare effects (including economies of scale, induced investment and growth effects, stimulus to technical change from increased outside competition, and macroeconomic output gains facilitated by the reduction in inflationary pressure) by considering the relationship of total welfare gains to static gains alone as measured in other studies of the experience of the European Common Market.

Exchange rate effects are calculated by considering aggregate export and import demand elasticities and computing the implied change in exchange rate required to eliminate any trade balance change initially induced by tariff cuts at home and abroad. Employment effects are calculated by applying "job coefficients" (both direct and "indirect" to account for intermediate goods requirements) to the changes in imports (job loss) and exports (job gain).

For Europe, the model has special treatment of the "substitution effect" through which outsiders (such as the United States, Japan, and Canada) increase their share in the market as the tariff walls around the EEC and EFTA decline. The model also includes the additional exports industrial countries may expect as developing countries "respend" their extra earnings of foreign exchange, gained from increased exports to the industrial areas reducing tariffs.

In the remainder of this section we state the formal structure of the model. The reader unconcerned with the algebraic formulation of the model is invited to proceed directly to section 3.

Define the following variables for a single "commodity" at the tariff line level:

M_j = import value for country j (in dollars)
o = superscript for base period
η_j = price elasticity of import demand, country j
t_j = MFN tariff rate for country j
T_j = $1 + t_j$ ("force of tariff"); $\dot{T}_j = \Delta t_j/[1 + t_j]$
σ = quantity elasticity of substitution among alternative suppliers
M_{ij} = value of imports of buyer j from supplying country i
TC,S = superscripts referring to "trade creation" and "substitution" respectively
Δ = change in variable.

For all importing countries j not belonging to the free trade bloc of the EEC and EFTA (for manufactures; EEC alone for agricultural products);

$$\Delta M_{ij}^{TC} = \eta_j \dot{T}_j M_{ij}^o . \tag{1}$$

For importing countries belonging to the bloc the corresponding equations are[2]

$$\Delta M_{ij} = \Delta_{ij}^{TC} + \Delta M_{ij}^S , \tag{2}$$

$$\Delta M_{ij}^{TC} = \eta_j \dot{T}_{ij} M_{ij}^o . \tag{3}$$

The substitution term for bloc imports is (see [8] for derivations of equations (4) and (5))

$$\Delta M_{ij}^S = \phi_{ij}^{NB} \; \phi_{NBj}^o \left(\frac{\phi_{Bj}^o \, \sigma \, \dot{T}_{NBj}}{1 + \phi_{NBj}^o \sigma \, \dot{T}_{NBj}} \right) M_j^o, \tag{4}$$

for $i \in NB$,

$$\Delta M_{ij}^S = - \phi_{ij}^B \; \phi_{NBj}^o \left(\frac{\phi_{Bj}^o \, \phi \, \dot{T}_{NBi}}{1 + \phi_{NBj}^o \, \sigma \dot{T}_{NBj}} - M_j^o \right) M_j^o, \tag{5}$$

for $i \in B$,

where

B,NB = bloc, nonbloc suppliers
ϕ_{NBj}^o = original share of nonbloc suppliers in country j's imports
ϕ_{Bj}^o = original share of bloc suppliers in country j's imports
ϕ_{ij}^{NB} = original share of supplier i of the nonbloc group within total nonbloc supply to country j
ϕ_{ij}^B = original share of supplier i of the bloc group within total bloc supply to country j

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[1] Note that in the general equilibrium model of the trade negotiations prepared by Deardorff, Stern, and Baum [9] the authors introduce an upward sloping supply curve under the assumption of fixed capital and output adjustment through labor change alone (based on constant elasticity of substitution estimates). This procedure would appear to bias upward the price effects of liberalization and, especially, the employment effects. Note also that the model computes trade effects at levels of aggregation well above the tariff line, ruling out examination of the key set of harmonization tariff-cutting formulas under consideration in the negotiations.

[2] In equation (3) the trade creation effect is the same as before, except that the force of tariff term has an additional subscript i because the tariff is specific to supplier: it equals zero for bloc partners ($i \epsilon B$) and the MFN tariff for nonbloc suppliers ($i \epsilon NB$).

$\dot{T}_{NBj}$ = proportional change in force of tariff facing nonbloc suppliers (and hence facing MFN tariff)

σ = elasticity of substitution in import demand among suppliers.

Note that $\phi^o_{NBj} + \phi^o_{Bj} = 1$.

The above equations complete the trade measurements of the model. These calculations exclude trade effects caused by input-output feedback. Those induced intermediate trade changes should be small (especially in the larger economies where most intermediate supply is provided domestically) and in any event should tend to cancel out each other (increased imports of intermediate supply needed to produce extra direct exports will offset reduced imports of intermediate goods associated with the reduction in domestic output as direct imports rise).

The measure of static welfare gain is the standard calculation (specified to include the case with a nonzero final tariff):

$$W = \Delta M^{TC}(0.5)\,(t^o + t^1), \tag{6}$$

where t^o and t^1 are tariff rates before and after liberalization. Importers inside the free trade bloc have an additional, corresponding welfare gain from trade substitution. For these countries static welfare gain is [8]

$$W = 0.5\,(t^o + t^1)\,(\Delta M^{TC} + M^o_{NB}\Psi), \tag{7}$$

where M^o_{NB} is the base level of imports from nonbloc suppliers and

$$\psi = \frac{\phi^o_{Bj}\ \sigma\,\dot{T}_{NBj}}{1 + \phi^o_{NBj}\sigma\,\dot{T}_{NBj}}$$

To consider the "respending effect," let ΔM_{ijk} be the increase of imports into industrial country j from a "free rider" country i (in practical application, all countries other than the eleven industrial importing areas examined directly in our study). Let subscript k refer to product category k. Let ϕ_{ij} be the fraction of country i's total imports purchased in industrial country j. Then for industrial country j, the extra exports to "free rider" countries caused by tariff liberalization is calculated as

$$\Delta X_j = \sum_i \phi_{ij} \sum_j \sum_k \Delta M_{ijk}.$$

That is, for each nonliberalizing country i there will be direct export gains totaling $\Sigma_j \Sigma_k \Delta M_{ijk}$. Of these export earnings, the fraction ϕ_{ij} will be respent on imports from country j — or, $\phi_{ij}\Sigma_j\Sigma_k\Delta M_{ijk}$ will be respent by free rider i in industrial country j. Summing up all free rider countries, industrial country j can anticipate the extra total exports shown in equation (8). Note that, unlike the calculations for direct trade effects of liberalization, the induced exports due to the respending effect cannot be broken down by commodity, because our coefficients for import propensities (ϕ_{ij}) are based on total import data rather than on data by commodity.

Given the estimates of trade balance changes resulting from a particular tariff-cutting formula, it is possible to calculate the implied offsetting change in exchange rates that would be necessary to restore the initial trade balance. Assuming infinitely elastic supply for imports and exports, an appreciation in the trade-weighted exchange rate of a country by the fraction dR will cause an increase in import value by $(dR)\,(\eta_m)\,(M^o)$ and a reduction in export value by $(dR)\,(\eta_x)\,(X^o)$, where η_m, η_x are overall price elasticities of demand for imports and exports, respectively, and M^o, X^o are the base values of imports and exports, respectively. With a trade balance effect of B caused by tariff liberalization, the trade-weighted exchange rate should move by just enough to cause an offsetting change in the trade balance of $-B$. Therefore, the required change in the trade-weighted exchange rate for a given country will be that shown in equation (9).

$$dR = \frac{-B}{\eta_m\,M^o + \eta_x\,X^o} \tag{9}$$

This method yields an estimate of the change in the trade-weighted exchange rate. In order to translate this change into a set of changes in nominal exchange rates from their original parities with respect to an unchanging outside standard, the calculation of equation (10) is applied.

$$\underset{m \times l}{\dot{R}^*} = \underset{m \times m}{[I - \phi]^{-1}}\ \underset{m \times l}{\dot{R}^o}, \tag{10}$$

where $\dot{R}^*$ is a vector of nominal exchange rate changes for all m countries; $\dot{R}^o$ is a vector of required trade-weighted exchange rate changes based on equation (9); I is the identity matrix; ϕ is a matrix of trade wieghts (with the elements in row i being the shares of each column country j in the total trade turnover — exports plus imports — of country i); and the expression $[I - \phi]^{-1}$ refers to the inverse of the $I - \phi$ matrix.

Finally, our estimates of employment effects apply "job coefficients" to the estimates of increased imports and exports (by product sector). This calculation provides an upper bound estimate of job changes, because it assumes that the entire change translates into output change; in practice, part of the trade change would be absorbed by change in domestic consumption. The calculations apply both direct labor coefficients and total coefficients, including labor required for intermediate inputs. Results on direct labor changes may be computed by product sector; total employment change by producing sector is unknown because the indirect labor component applicable to a given trade product is not allocated across producing sectors. (In addition our employment estimates omit extra jobs from induced exports under the respending effect, because this export effect is not calculated on a product sector basis.)

3. Estimates of Trade, Welfare, and Exchange Rate Effects

We have applied the model of tariff negotiations to the trade and tariff data base provided by GATT for the negotiations (with 1971 trade data and 1973 tariffs). Because 1971 was a year of major disequilibrium as well as one now seriously outdated, we have updated all results by applying more than 8,000 trade base expansion factors based on detailed O.E.C.D. trade value data for 1971 and 1974 (see [8, Appendix B]). For import elasticities we have applied the best detailed empirical estimates available from existing studies (see Appendix A). The resulting aggregate import elasticities are comparable for the major importing areas (United States, −1.85; Canada, −1.94; Japan, −1.39; EEC — for imports from nonbloc suppliers — −2.17).

We have applied the model of tariff liberalization to twelve separate tariff cutting formulas, summarized in Table 1. The most basic formulas are the first three and the sixth — all actively under consideration in the negotiations during 1975 and 1976. The first formula is a 60 percent linear tariff cut, the hypothesis submitted by the United States early in the negotiations. The formal proposal subsequently tabled by the United States in March 1976 departs little from the 60 percent cut although it cuts tariffs below 7 percent by slightly less.[3] The second formula is a harmonization approach suggested by the EEC early in the negotiations: three iterations of a percentage cut in the tariff equal to the tariff (on the previous round) itself. In July 1976 the EEC formally proposed the same formula with four iterations — a very minor change [22].[4]

Table 1

Tariff Cutting Formulas Examined

Formula Number	Tariff Cut Equation†	Verbal Description
1	$y = 0.60$	60 percent linear cut
2	$t_1 = t_o(1-t_o)$ 3 times	Three-iteration harmonization (EC variant)
3	If $t_o < 5\%, t_1 = 0$ $t_o > 40\%, t_1 = 20\%$ Otherwise $t_1 = 0.5t_o$	Canadian-type formula
4	$y = 1.0$	100 percent linear cut
5	$y = 0.3 + t_o$	Harmonization, 30 percent plus tariff
6	$t_1 = 0.03 + 0.4\, t_o$	60 percent cut plus absolute 3 percent tariff
7	$y = 0.434$	43.4 percent linear cut
8	$y = 0.60$; if $t_o < 0.05\ t_1 = 0$	Full U.S. authority
9	$y = 0.60$ except: if $t_o < 0.05\ t_1 = t_o$ if $t_o < 0.125\ t_1 = 0.05$	60 percent cut with 5 percent floor
10‡	$t_1 = \min \begin{matrix} t^* \\ t_o \end{matrix}$	Sector harmonization (t^* = four-area BTN minimum tariff
11‡	$y = 0.2 + 3\, t_o$	Harmonization, 20 percent plus 3 times tariff
12‡	$t_1 = t_o\ (1-t_o)$ 6 times	Six-iteration harmonization

† y is proportionate tariff cut; t_o is original tariff; t_1 is tariff after cut.

‡ Subject to maximum cut of 60 percent.

The contrast between formulas 1 and 2 reflects the issue of linear versus harmonization cuts inherited from the Kennedy Round. With relatively uniform tariffs already harmonized by the process of integration, the EEC has favored harmonization as the principle of tariff cutting. The United States traditionally has preferred linear cuts, although if the textiles sector is excluded it appears that there is little advantage to the United States in linear as opposed to harmonization formulas [8]. Indeed, the more important difference between the two formulas is the fact that the second formula would cut tariffs by only about half as much as the 60 percent cut, because when applied to the average tariff of approximately 10 percent, the three-iteration approach yields modest cuts.

The third formula resembles suggestions by Canada. It eliminates tariffs under 5 percent (crucial to a broad set of Canadian exports to the United States), cuts others in half, and sets a maximum resulting tariff of 20 percent.

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[3] The U.S. formula tabled in March 1976 is: $y = 1.5x + 50$, where y is percentage cut and x is original tariff. The formula is subject to a maximum cut of 60 percent. (Calculated from [14].)

[4] Note that in the iterative formula tariffs originally higher than 50 percent are cut to the new level applicable for a 50 percent tariff (a final tariff of 15.23 percent).

Formula 6 is also closely related to an actual proposal in the negotiations. It involves a tariff cut of 60 percent, but with a subsequent tariff shelf of 3 percent added back in (though in no case is the original tariff increased). Thus it strongly resembles the Japanese formula tabled in October 1976.[5]

The remaining nine formulas are exploratory; none of them has been as actively considered in the negotiations as the first three Formula 4 is the complete elimination of tariffs, to provide a benchmark for fully liberalized trade (with respect to tariffs alone). Formula 5 is a harmonization variant; seven, an intermediate linear cut. Formula 8 is full U.S. tariff-cutting authority (60 percent cut with tariffs of 5 percent and less eliminated). Formula 9 sets a 5 percent floor and cuts tariffs by 60 percent otherwise. Formula 10 reduces tariffs in each four-digit BTN category to the minimum sectoral average tariff among the United States, Canada, Japan, and the EEC. Formula 11 is a particular harmonization variant (percent cut equals 20 percent plus three times tariff); formula 12 is six iterations of tariff cut equal to tariff. The final three formulas all constrain the cuts to a maximum of 60 percent (in accordance with the U.S. authority).

The basic estimates applying these formulas exclude petroleum products (as outside the domain of tariff policy) and textiles (as politically sensitive, controlled by quotas, and highly unlikely to be liberalized in the Tokyo Round).[6] The resulting aggregate trade and welfare calculations for each formula are shown in Table 2, along with the average depth of tariff cut associated with each formula.[7]

The first and most important policy question to be examined is: What are the potential economic benefits from tariff liberalization in the negotiations? Under full U.S. tariff-cutting authority (formula 8) the annual stream of static welfare benefits from liberalization would be $1.7 billion. On the basis of recent estimates by Balassa for the case of the formation of the European Common Market, we might conservatively estimate total welfare gains (including nontraditional static and dynamic effects mentioned above) to be five times as large as the static effects alone, giving an annual flow of $8.5 billion in aggregate welfare.[8] Under the assumption that this stream would grow at the same real rate as the trade base, say 5 percent annually, and discounting at a 10 percent per annum rate, the present discounted value of the stream of future total welfare benefits would approximate $170 billion (in 1974 values). Therefore, the economic stakes of tariff liberalization in the Toyko Round are large.

With respect to the magnitude of trade effects, Table 2 indicates that the complete elimination of tariffs would increase imports into the eleven industrial areas (the United States, Canada, Japan, EEC, five EFTA countries, Australia, and New Zealand) by approximately $17 billion, or about 3 percent of total imports in 1974 and 11 percent of the relevant trade base, which excludes petroleum, textiles, duty-free goods, intra-EEC/EFTA, and imports under agricultural variable levies.[9]

The aggregate results shown in Table 2 indicate essentially three clusters of trade creation effects. The first, benchmark level is the amount of trade created by complete elimination of tariffs. A second level represents a cluster of formulas that go only about two-thirds of the way toward the free trade result: the full U.S. authority formula (8), a 60 percent tariff cut (formula 1), and the formula similar to suggestions by Canada (formula 3).

The third and lowest tier of formulas goes only about one-third of the way to the trade effect of complete tariff elimination. This lowest cluster of formulas creates only about $5½ billion in new trade. This grouping of formulas includes the three-iteration harmonization cut (formula 2), the sector harmonization approach (formula 10), and the 60 percent cut with a 3 percent tariff shelf added to all resulting tariffs.

Other formulas lie in between these three tiers. However, the two most important alternatives in view of the actual negotiations are in two clusters. The early U.S. suggestion of a 60 percent tariff cut is in the intermediate tier and the EEC-type cut (three-iteration har-

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[5] The Japanese proposal was $z = 0.3x + 3.5$, where z is the final tariff expressed as a percentage, and x is the original tariff. The Japanese proposal differs from formula 6 here only by using a 70 percent instead of a 60 percent linear element (in the direction of greater liberality) and an add-on of 3.5 percent instead of 3 percent (in the direction of greater restriction) [7].

[6] In addition, U.S. imports from Canada under preferential agreement are excluded from the calculations.

[7] Calculated as total tariff collections foregone (base value of imports times change in tariff) as a fraction of hypothetical base-level tariff collections.

[8] Balassa's estimates indicate that when adding gains from economies of scale and from increased growth due to induced investment, welfare gains from EEC integration rise to approximately six times the static welfare gains from trade creation alone (excluding losses from trade diversion) [1, pp. 113–15].

[9] Trade for 1974 [12]. Approximate estimates of subcategories based on [18] and on the GATT trade and tariff data base.

Table 2

Total Import and Welfare Effects of Alternative Tariff-Cutting Formulas for Eleven Industrial Importing Areas
($ millions, 1974)
(Nontextile, nonoil trade)

	A		B		C	D	
	Imports*	(Rank)	Welfare (Static Effects)	(Rank)	Welfare/ Imports	Average Depth of Cut 4 Areas†	(Rank)
1	10,158	(3)	1,681	(3)	0.165	60%	(3)
2	5,738	(11)	1,397	(9)	0.243	33.3	(10)
3	9,780	(4)	1,601	(6)	0.164	59.1	(4)
4	16,930	(1)	1,991	(1)	0.118	100.0	(1)
5	7,989	(6)	1,603	(5)	0.201	46.4	(6)
6	5,411	(12)	1,330	(11)	0.246	29.9	(11)
7	7,449	(8)	1,374	(10)	0.184	43.4	(7)
8	10,976	(2)	1,686	(2)	0.154	65.2	(2)
9	7,566	(7)	1,568	(7)	0.207	42.0	(8)
10	5,769	(10)	1,098	(12)	0.190	23.2	(12)
11	8,670	(5)	1,622	(4)	0.187	49.9	(5)
12	7,403	(9)	1,530	(8)	0.207	42.0	(9)

Notes: See Table 1 for description of formulas. The eleven areas are United States, Canada, Japan, EEC, Austria, Finland, Norway, Sweden, Switzerland, Australia, and New Zealand.

*Net of reduced imports by EEC member countries from each other.

†See [8].

monization) is in the lower tier. Thus, the U.S. tariff cut formula would create approximately twice as much trade as the EEC formula ($10.2 billion and $5.7 billion, respectively).

Table 2 shows the average depth of tariff cut for the United States, Canada, Japan, and the EEC. As would be expected, the ordering of formulas by amount of trade created closely parallels their ordering on the basis of average depth of cut.

Finally, as shown in the table, the level of static welfare gain associated with each formula has a ranking almost identical to that for the level of trade creation. However, the amount of welfare gain relative to trade creation is the highest for the harmonization formulas (2, 5, 11, 12). This pattern reflects the fact that the welfare gain rises geometrically with the level of tariff, so that harmonization formulas — which cut higher tariffs by greater proportions than lower tariffs — produce greater welfare gains per unit of trade change than do linear formulas.

The results in Table 2 refer to liberalization excluding textiles. However, it is important to recognize that increased textile imports could be extremely large if liberalization extended to this politically sensitive sector. This study assumes that textiles will not be liberalized, but the calculations consider the impact that liberalization in the sector would have. The inclusion of the sector in liberalization would raise total import creation by approximately 30 percent.[10]

In order to consider the negotiating positions of individual areas, it is necessary to turn from aggregate estimates to calculations by country. Table 3 presents our estimates of changes in imports and exports (including those induced by the respending effect) for each of the four major negotiating partners.[11] A broad pattern of the results immediately evident in Table 3 is that the United States and Japan tend to experience trade balance increases while Canada and the EEC experience trade balance declines from liberalization regardless of the formula chosen, although the magnitudes of the changes depend on the formula.

These overall country patterns may be explained as follows: for Japan, a strong competitive position and positive trade balance in the 1974 base year (at least for items included in the analysis, which omits petroleum)

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[10] Calculations including textiles (presented in [8]) assume that quotas are at levels that allow domestic price to exceed the import price by precisely the amount of the tariff. If quotas are more stringent, then increased imports from the joint reduction of tariff and quota protection would be still greater.

[11] The trade effects for the five EFTA countries considered (Austria, Finland, Norway, Sweden, and Switzerland) are much smaller; and it is unclear whether Australia and New Zealand will adopt a general negotiated formula in any event.

Table 3

Trade Effects of Alternative Tariff-Cutting Formulas: Four Major Negotiating Areas ($ Millions of 1974; Results Exclude Textiles and Petroleum)

Formula (1)	Imports (2)	Exports (Direct) (3)	Trade Balance (Direct) (4)	Exports (Respending Effect) (5)	Total Exports (6)	Trade Balance (Total) (7)
			A. United States			
1	3,611	3,821	211	421	4,242	632
2	1,924	1,875	− 49	224	2,099	175
3	3,773	3,460	− 313	387	3,847	74
4	6,018	6,321	303	708	7,029	1,011
5	2,820	2,756	− 63	322	3,078	259
6	1,639	1,966	327	216	2,182	543
7	2,648	2,811	163	315	3,126	478
8	4,130	4,019	− 112	460	4,479	348
9	2,225	2,941	716	307	3,248	1,023
10	1,736	2,514	778	119	2,633	897
11	2,858	3,294	437	359	3,653	796
12	2,391	2,732	340	303	3,035	643
			B. Canada			
1	1,680	565	−1,116	51	616	−1,065
2	922	249	− 673	34	283	− 639
3	1,431	603	− 828	51	654	− 777
4	2,801	936	−1,864	85	1,021	−1,779
5	1,255	400	− 855	45	445	− 810
6	1,023	221	− 802	29	250	− 773
7	1,232	415	− 817	38	453	− 779
8	1,705	664	−1,041	56	720	− 985
9	1,500	326	−1,174	38	364	−1,136
10	1,314	313	−1,002	12	325	− 990
11	1,561	436	−1,125	44	480	−1,081
12	1,342	349	− 993	38	387	− 955
			C. Japan			
1	1,736	2,237	501	326	2,563	827
2	1,067	1,157	90	193	1,350	283
3	1,683	2,176	493	287	2,463	780
4	2,894	3,709	815	539	4,248	1,354
5	1,424	1,687	263	260	1,947	523
6	994	1,106	112	186	1,292	298
7	1,273	1,644	371	240	1,884	611
8	1,834	2,458	624	340	2,798	964
9	1,385	1,586	201	259	1,845	460
10	927	1,318	392	105	1,423	497
11	1,521	1,866	346	287	2,153	633
12	1,312	1,556	243	250	1,806	493
			*D. EEC**			
1	4,495	2,293	−2,202	882	3,175	−1,320
2	2,130	1,575	− 555	470	2,045	− 85
3	4,105	2,244	−1,861	813	3,057	−1,048
4	7,376	3,827	−3,549	1,453	5,280	−2,096
5	3,201	2,046	−1,165	673	2,719	− 492
6	2,215	1,370	− 845	460	1,830	− 385
7	3,318	1,681	−1,637	650	2,331	− 987
8	4,746	2,466	−2,280	952	3,418	−1,328
9	3,339	1,768	−1,571	627	2,395	− 944
10	2,214	1,540	− 674	269	1,809	− 405
11	3,793	1,985	−1,808	736	2,721	−1,072
12	3,125	1,775	−1,350	621	2,396	− 729

*Refers to trade of EEC with nonmember countries, and therefore excludes changes in trade among countries within the EEC.

dominate the results and yield positive trade balances generally from liberalization. For the United States, the driving forces behind the results appear to be the significant opening of Canadian and EEC markets through liberalization — the first because of high Canadian tariffs, and the second because of the opportunity to replace privileged EEC suppliers as the tariff wall declines.

An important feature of the Canadian case which helps explain her trade balance reductions under liberalization[12] is that Canada has high tariffs on those products that are subject to duty (14.2 percent on dutiable goods, compared with 10.7 percent for the eleven industrial areas altogether) [11]. In addition, Canada primarily exports raw materials already facing low tariffs abroad (or else subject to agricultural nontariff barriers).

In the case of the EEC, one reason for the pattern of negative trade balance effects is the substitution effect through which partner supplies are replaced by imports from outside areas. However, this effect is probably of relatively limited importance, in view of the fact that even taking the substitution into account the import elasticity of the EEC for purchases from outside areas is not dramatically higher than the import elasticity of other major countries.[13] Another important factor appears to be that in the estimated trade effects the community experiences a relatively high increase in imports from the "rest of the world," making the free rider problem somewhat greater for the EEC than for other areas.[14]

Despite these patterns, the salient feature of the trade balance effects is that they are all extremely small. Under the 60 percent tariff cut, for example, the trade balance increase for the United States would amount to only 0.6 percent of 1974 exports; that for Japan, 1.5 percent. Similarly, the trade balance decline for Canada would represent 3.1 percent of 1974 exports; that for the EEC would be 1.0 percent of 1974 exports to nonmember countries (see Table 6 for 1974 export data). Keeping in mind the fact that even these small changes would be phased in over a period of five or more years, the principal conclusion must be that under whatever tariff formula any trade balance declines would be too inconsequential to constitute a significant problem for economic policy.[15]

Before turning to the issue of preferred rankings of tariff formulas, it is important to emphasize that the trade effect estimates should not be considered to be highly precise despite the fact that the estimates apply the best empirical information available.[16]

The estimates for export, import, and welfare effects of alternative tariff-cutting formulas provide the basis for examining each negotiating country's presumed ranking of the various formulas. Those rankings in turn constitute the grounds for determining which formulas would be the most desirable for all negotiating countries considered jointly. The following discussion of these questions concentrates on the results of the four major negotiating areas: the United States, Canada, Japan, and the EEC.

There are two broad criteria for ranking the tariff formulas for each country: welfare effects and trade effects. Table 4 presents the static welfare effects by formula for the four major negotiating parties. Assuming that total welfare gains have the same rank ordering as static welfare gains, we assume that each area ranks the formulas as shown in the table.

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[12] Note that the reduction may be overstated because the model does not capture industrial transformation from raw materials exporting to the production and export of processed goods, an effect particularly important for Canada (and for the developing countries).

[13] Incorporation of the substitution effect gives the EEC an aggregate price elasticity for imports from outsiders of −2.17, only slightly larger in absolute value than the elasticities for the United States (−1.85) and Canada (−1.94). The aggregate elasticity for Japan is somewhat lower: −1.39.

[14] Rest of world suppliers (free riders not reducing their own tariffs) account for 43 percent of increased EEC imports from non-EEC countries, whereas the corresponding share of rest of world supply is 33 percent for increased imports by Japan, 4.6 percent for Canada, and 19 percent for the United States.

[15] Note furthermore that even the moderate deficits identified for Canada and the EEC would be still smaller if our methodology forced the elimination of any "leakage" in the respending effect estimates. Because free rider countries do not purchase all of their extra imports from the eleven liberalizing areas, only a portion of the export earnings of the "rest of world" (57 percent of the $3.3 billion earned by free rider countries, in the 60 percent tariff cut case) returns to the liberalizing areas in our respending effect estimates of induced exports. If a full 100 percent were forced to return, allocating the extra respending exports proportionately to the estimates above (for the comparable but smaller respending effect), the specific trade balance estimates would change but the qualitative patterns by country and formula would not. (For the 60 percent tariff cut, the trade balance would change as follows: United States, from +$632 million to +$951 million; Canada, from −$1,065 million to −$1,026 million; Japan, from +$827 million to +$1,074 million; EEC, from −$1,320 million to −$652 million.

[16] In order to examine the sensitivity of the results to the particular elasticities used, we have conducted experiments raising all elasticity values by 50 percent and lowering them all by 50 percent for the United States, Canada, Japan, and the EEC (giving 81 possible combinations when the original elasticities are included as a third option). In statistical terms, a band of 50 percent around a statistically significant parameter (with a ratio of standard deviation to parameter estimate of one-half or less) should include the true parameter value with a probability of at least 68 percent, for a normally distributed random variable as parameter estimate.

The results of this sensitivity analysis indicate that there could be a considerable range of uncertainty in the trade balance estimates. For example, under a 60 percent tariff cut, in one-third of the cases the trade balance effect for the EEC is positive rather than negative; similarly, in 47 percent of the cases the trade balance effect could be negative for the United States rather than positive (as in our central estimate; both statements refer to effects including respending exports).

Table 4
Static Welfare Gains from Alternative Tariff-Cutting Formulas: Four Major Negotiating Parties ($ millions of 1974; nontextile)

Formula	USA	CAN	JPN	EEC
1	490.3(4)	178.2(3)	289.3(5)	451.2(3)
2	437.8(9)	124.5(12)	268.5(9)	304.4(11)
3	470.3(6)	159.4(7)	296.2(2)	415.5(5)
4	583.7(1)	212.1(1)	344.4(1)	527.7(1)
5	491.0(3)	151.5(8)	293.7(3)	384.6(7)
6	395.2(12)	134.4(11)	244.4(10)	317.8(10)
7	400.6(10)	145.6(10)	236.4(11)	374.3(9)
8	491.1(2)	178.4(2)	289.9(4)	453.0(2)
9	448.9(8)	171.5(5)	276.8(7)	409.4(6)
10	395.4(11)	150.2(9)	83.7(12)	235.1(12)
11	470.8(5)	174.0(4)	281.7(6)	426.9(4)
12	451.1(7)	160.4(6)	270.5(8)	384.5(8)

For all areas the highest welfare ranking is for formula 4, the elimination of tariffs. For the United States, Canada, and the EEC, the highest ranked practical formula is full U.S. authority (formula 8). For Japan, because of the existence of high tariffs in some sectors, welfare gains are higher under harmonization formulas 3 and 5 than under the full U.S. authority cut.

The second criterion for judging liberalization alternatives is that of the degree of reciprocity of trade effects. Under this criterion, ceteris paribus, a country prefers those formulas that increase its exports relatively more than its imports. Economists have faulted negotiators as irrational for pursuing reciprocity or trade balance objectives in view of the welfare gains from import liberalization by itself; or, as a minimum, negotiators have been viewed as seeking objectives such as a preference for industrial output and employment, outside the realm of traditional welfare gains [13]. However, for two reasons it is reasonable for negotiators to consider export effects relative to import effects. First, negotiations represent a bargaining situation. The bargaining objective, as distinct from an objective that could be pursued by each country in isolation, is to obtain the maximum possible liberalization of export markets in exchange for the liberalization of the home country's own import market. If import liberalization alone were the objective, each country could reduce tariffs unilaterally; it would be unnecessary to hold negotiations in the first place.

A second reason for attention to trade effects is that if a country's imports will increase far more than its exports from a particular proposal, the country will face adjustment costs necessary to offset the trade balance reduction. Under fixed exchange rates these costs (except for reserve currency centers) may involve recessionary measures reducing domestic output. Under flexible exchange rates, the adjustment cost will involve exchange rate depreciation and therefore, under the normal assumption of high supply elasticities for imports and exports, a decline in the country's terms of trade [17]. For countries usually in payments surplus conditions, this cost will be negligible (because they would otherwise appreciate); countries facing chronic payments deficits would have a higher cost associated with additional depreciation induced by changes in protective structure domestically and abroad. In the current international economic situation, ongoing trade deficits associated with higher prices for petroleum imports constitute one reason for at least some attention to potential trade balance reductions from other sources.

We have specified the trade effects criterion as the average of rankings under two alternative measures: the trade balance effect, and the percentage increase in exports relative to the percentage increase in imports. The latter measure captures the extent to which a formula achieves the negotiating objective of a country likely to experience, because of its protective and trading structure, a reduction in trade balance as such, but nevertheless willing to participate in the negotiations as a means of obtaining the maximum liberalization by partners. Similarly, the relative rather than absolute specification helps abstract from the particular year of the trade data base, considering that liberalization will tend to show reduced trade balance when the base year is one of deficits and increased trade balance when the base is a surplus year.

Table 5 presents formula rankings by major negotiating party under the trade and welfare criteria. Under the trade effect criterion the highest ranked formula for the EEC is its own proposal (formula 2); the same is true for Canada (formula 3). However, in neither case is the country's proposal the formula ranking highest under the country's own welfare ranking. For the United States, the 60 percent proposal ranks intermediately under trade effect criteria but high under the welfare criterion, suggesting that U.S. objectives give substantial weight to welfare gains.[17] For Japan, trade effects criteria indicate that most liberal formulas (full U.S. authority, formula 8, and the 60 percent cut) are the most desirable. The welfare criterion shows a high ranking for these formulas as well, although the ranks of the harmonization formulas 3 and 5 are still higher. Paradoxically, the formula closest to Japan's own

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[17] Formula 9, a 60 percent cut with a 5 percent tariff floor, is tied for the highest U.S. ranking under trade effects. This result emphasizes the key role of the broad set of imports already entering the United States at tariffs of 5 percent or lower.

Table 5

Consolidated Rankings of Alternative Tariff Cutting Formulas (1974, Nontextile Basis)

FORMULA*	I. Trade Effect Rankings†					II. Welfare Rankings					III. Sum (I + II)
	U.S.	CAN	JPN	EEC	4-areas‡	U.S.	CAN	JPN	EEC	4-areas‡	
1	6	7	2	11	7.307(9)	3	2	4	2	2.684(2)	9.991(3)
2	9	2.5	11	1	5.927(5)	8	11	8	10	8.959(9)	14.886(10)
3	11	1	4	6.5	7.722(11)	5	6	1	4	4.303(5)	12.025(7)
5	9	5	7	3	6.378(7)	2	7	2	6	3.821(4)	10.199(4)
6	4.5	6	10	2	4.443(2)	11	10	9	9	10.005(10)	14.448(9)
7	7	2.5	4	9	6.886(8)	9	9	10	8	8.781(8)	15.667(11)
8	9	4	1	9	7.595(10)	1	1	3	1	1.230(1)	8.825(1)
9	1.5	11	9	6.5	4.954(3)	7	4	6	5	5.926(6)	10.880(5)
10	1.5	9.5	4	4	3.399(1)	10	8	11	11	10.255(11)	13.654(8)
11	3	9.5	6	9	5.980(6)	4	3	5	3	3.684(3)	9.664(2)
12	4.5	8	8	5	5.409(4)	6	5	7	7	6.352(7)	11.761(6)

*Original formula 4 (100 percent tariff cut) omitted. Ranks are adjusted accordingly.

†Trade effect rankings based on case including exports due to rest of world respending. Average of rankings for (1) trade balance and (2) ratio of percentage increase in exports to percentage increase in imports.

‡Applies the following weights to country rankings: U.S., 0.454; Canada, 0.097; Japan, 0.115; EEC, 0.334. See text.

proposal, number 6, ranks very low for Japan on both trade and welfare criteria.

Before turning to an assessment of the best overall tariff cutting formula judged jointly for the major negotiating countries, we consider the implications of Tables 4 and 5 for the issue of linear versus harmonization tariff cuts. In the Kennedy Round this issue was highly controversial, with the EEC favoring harmonization and the United States favoring linear cuts [20, pp. 3–4]. Without entering into detail on the case for harmonization or linear cuts,[18] we note that in practice the issue appears to have been inflated out of proportion. If textiles are excluded, linear cuts do not have a more positive effect on the U.S. trade balance than harmonization cuts. Trade results depend on the depth, and the particular specification, of the cut. In fact the largest trade balance increase for the United States occurs under a particular type of harmonization formula: a 60 percent cut with a 5 percent floor on tariffs. Another result concerning harmonization is that the EEC-type harmonization cut creates little trade. Alternative harmonization approaches create much more trade, and if the EEC commitment is to the concept of harmonization per se rather than to restrictive tariff cuts, then it should be possible to identify harmonization formulas that are much more favorable to overall trade creation and welfare gains than the three- (or four-) iteration cut suggested by the EEC.[19]

Viewing the negotiations as a whole, the most interesting question is: Which tariff-cutting formula should be adopted in order to maximize the joint preference rankings of the negotiating partners? To examine this question it is necessary to make two decisions on weighting procedure. The first concerns the relative weight assigned to trade effect as opposed to welfare effect rankings. We assign a weight of one-half to each, in the absence of further information on the social objectives of countries in the negotiations.[20] The second weighting question is the appropriate weight to assign to each country in arriving at an overall weighted average representing the joint interests of participants in the negotiations. For these weights we use the share of each area in the value of total dutiable imports. It is this economic good — the magnitude of the market protected by duties — that each partner is offering to the others as its own contribution in the liberalization effort. Therefore, this base is a reasonable gauge of the voice each area should have in liberalization decisions.

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[18] Note that the relative theoretical merits of linear versus harmonization cuts are ambiguous. Advocacy of linear cuts implies that "bygones are bygones"; high tariffs exist because of political considerations in the past, and a liberalizing country has an obligation to cut all tariffs, low or high. The case for harmonization is usually made in terms of the proposition that high tariffs are "more protective," proportionately, than low tariffs. (The implication here is that a tariff of $2t$ on good A represents more than twice the amount of protection afforded by a tariff of t on good B having equal import value net of tariff.) This viewpoint would be wrong from the standpoint of the proportionate price effect of tariff reduction (because of the existence of the tariff in the denominator, with a higher tariff causing a lower proportionate price reduction for a given fractional tariff reduction). The position might have some merit insofar as tariff categories with high tariffs have lower import value entries than categories with low tariffs (the familiar tariff weighting problem). However, a much more enlightened argument for harmonization would be the fact that a harmonization cut will generate higher static welfare gains per unit of import increase than a linear cut with equal average depth of cut (because the harmonization cut will focus on higher tariffs, and the static welfare gain rises as the square of the tariff). If adjustment costs are proportional to the change in import value, then this consideration would make a harmonization cut more "efficient" (a higher benefit-cost ratio) than a linear approach. However, all of these considerations are valid only if the particular linear and harmonization options are equally liberalizing on average, creating comparable amounts of new trade.

[19] Moreover, there is little substance in the notion that the EEC could maintain the "cement in the tariff wall" more effectively through restrictive rather than generous liberalization in the Tokyo Round. With the common external tariff already as low as 10 percent on the average, remaining tariffs after further liberalization will play primarily a symbolic role in supporting unity of the EEC. This symbolic role can be as easily performed by a 4 percent external tariff as by a 7 percent tariff (the resulting levels after a 60 percent cut and a 30 percent cut — implied by the three-iteration formula — respectively).

As shown in the final column of Table 5, the consolidated rankings indicated that the most preferred formula under the joint criteria of trade effects and welfare effects, considering the weighted perferences of the four major negotiating areas, is the most liberalizing practical formula: full U.S. tariff-cutting authority (60 percent cut, and the elimination of tariffs under 5 percent). The second overall ranking is for formula 11, a harmonization formula of the form: percent cut equals 20 percent plus three times the tariff, subject to maximum cut of 60 percent. For practical reasons this formula is of great interest, because in the strategic range of tariffs from 5 percent to 13 percent it represents a cut that is intermediate between the initial U.S. proposal (60 percent cut) and the initial EEC formula (three-iteration harmonization, formula 2).[21] In terms of welfare gain, this compromise formula would sacrifice very little of the welfare gains possible under the full U.S. authority formula (see Table 2, column B).

A 60 percent tariff cut ranks third under the joint ranking, indicating that this formula (the one most similar to the U.S. proposal) is fairly close to the best solution for all parties jointly. By contrast, the iterative harmonization formula 2 (the formula closest to the EEC proposal) ranks next to last under the joint ranking, suggesting that a considerable sacrifice in the overall objectives of all parties considered jointly would occur if this approach were adopted. The reason for the formula's low rank is its poor performance under the welfare criterion, attributable to its relatively restrictive nature.[22]

These results complete our analysis of possible trade and welfare effects of tariff liberalization in the Tokyo Round. Before turning to employment effects, we may consider the exchange rate effects that might follow liberalization. Table 6 presents estimates of these effects for the case of a 60 percent tariff cut. These estimates are based on the method described in section 2, using the aggregate import elasticities reported in Appendix A and assuming a price elasticity of foreign demand for exports of − 2.0 for each country or area. As may be seen in the table, all exchange rate changes would be trivial in size with the possible exception of the case of New Zealand, so that further examination of exchange rate effects by tariff-cutting formula is unnecessary.

4. Employment Effects

A potential source of political opposition to trade liberalization is organized labor. Fears of job displacement from imports have contributed to such protectionist efforts in the recent past as the Burke-Hartke bill introduced in 1971. Therefore it is important to examine the likely consequences of liberalization in the Tokyo Round for employment in the United States and other major negotiating countries.

We have applied the method described in section 2 to estimate employment changes from tariff liberalization in the United States, Canada, Japan, and the EEC. Labor and input-output data were directly available for the United States and Japan; for Canada, we have assumed that U.S. direct and indirect labor coefficients apply; for the EEC, we have applied direct labor coefficients drawn from United Nations estimates; but we have made no estimates of indirect employment effects in the case of the EEC.[23]

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[20] Economists traditionally would assign a higher weight to welfare effects; most negotiators traditionally would probably assign somewhat more weight to trade effects — although some negotiators would probably seek to "satisfice" rather than maximize trade balance objectives, pursuing a rough equivalence of export and import effects. See [10].

[21] This compromise feature holds true even when considering the later, formal proposals of the two parties: respectively 60 percent cut with slightly smaller cuts for tariffs below 7 percent, and four iterations of the harmonization formula.

[22] Finally, although of limited use for the overall evaluation of the formulas, the weighted average rankings based on trade effects alone deserve comment. Under this measure (part I, table 5) restrictive formulas rank high, partly because they limit the size of any trade balance reduction that an area can experience. The highest ranking under this measure is for formula 10, sector harmonization — although this result requires the unrealistic assumption that countries other than the four major areas would accept the formula even though it is based on minimum sectoral tariff among these four areas alone. Note also that the final joint ranking is heavily influenced by the welfare rankings, because these tend to be unanimous among the four areas.

[23] For a discussion of data sources, including procedures for adjusting data to comparable years, see [8, chap. 3].

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Table 6

Changes in Exchange Rates Required to Offset Trade Balance Effects of a 60 Percent Tariff Cut (Nontextiles, Nonoil)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
						Exchange Rate Change	
Country	Trade Balance Effect ($ million)	1974 Imports ($ billion)	1974 Exports ($ billion)	Import Elasticity	Export Elasticity	Trade-Weighted (percent)	Nominal (percent)
United States	632	108.0	98.5	1.82	−2.0	0.16	−0.28
Canada	−1,065	34.6	34.2	−1.94	−2.0	−0.79	−1.13
Japan	827	62.1	55.6	−1.39	−2.0	0.42	0.16
EEC	−1,320	151.0	133.9	−2.17	−2.0	−0.22	−0.79
Austria	16	9.0	7.2	−0.65	−2.0	0.08	−0.64
Finland	−49	6.8	5.5	−0.61	−2.0	−0.32	−1.08
Norway	−41	8.4	6.3	−1.72	−2.0	−0.15	−0.89
Sweden	−75	15.8	15.9	−1.50	−2.0	−0.14	−0.90
Switzerland	93	14.4	11.9	−0.69	−2.0	0.28	−0.44
Australia	−275	12.4	11.0	−1.24	−2.0	−0.73	−1.17
New Zealand	−175	3.7	2.4	−1.23	−2.0	−1.87	−2.48

Sources: Columns (2), (5): [8]. Columns (3), (4): [12, February 1976, pp. 38–39]; and [8, Appendix B]. Column (6): assumed values. Columns (7), (8): calculated from columns (1) through (6); trade shares used in the calculation of column (8) are based on [19].

*EEC entries refer to trade external to the EEC.

Table 7 reports the estimates of employment effects for each area under the twelve alternative tariff-cutting formulas examined. It must be recalled that these estimates tend to exaggerate job changes because they assume all trade changes translate into production changes, while in fact a part of the change in trade would represent change in consumption. In addition, the estimates are biased downward for the creation of new export jobs, because they omit increased jobs attributable to exports induced by the respending effect. Despite these facts, the resulting estimates show extremely small employment effects resulting from liberalization even under the complete elimination of tariffs, formula 4. For the United States and Japan, the gain in export jobs generally would exceed losses of jobs in import competing sectors; for Canada and the EEC there would tend to be net job losses, but these would be small, especially considering the bias due to exclusion of export jobs induced by the respending effect. The net job effects by formula tend for each country to parallel the results examined above for trade effects.

By far the most important implication of the results presented in Table 7 is that under all formulas the employment effects are very small. Considering the most liberalizing practical formula, full U.S. authority (formula 8), the net job balance between export and import job changes would be only +0.02 percent for the United States, −0.53 percent for Canada, +0.08 percent for Japan, and considering direct jobs only, −0.11 percent for the EEC [18]. The results are similarly minimal, all well under 1 percent of labor force, even if attention is limited only to the reduction in jobs attributable to increased imports, giving no credit to increased export jobs. Moreover, even these small employment effects would be spread over five years or more due to the phasing-in of tariff reductions.

The analysis of employment effects might be extended by considering the present discounted value of adjustment costs for workers losing jobs to increased imports (see [5]). These welfare costs could in principle be compared with the total welfare gains from liberalization. However, in view of the small size of the employment effects estimated here, it appears unwarranted to go into greater detail on the present value of adjustment costs. Our qualitative conclusion that employment effects would be extremely small is supported by similar results from a model of liberalization effects on the United States, prepared by Baldwin [3], and from a multilateral liberalization model prepared by Deardorff, Stern, and Baum [9].[24]

It is possible that employment problems could arise from liberalization in individual product sectors even though aggregate employment effects would be negligible. Table 8 reports our employment estimates for the United States by BTN section; similar tables for Canada, Japan, and the EEC appear in Appendix B.

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[24] Despite the fact that this model gives an upward bias to estimated employment effects as noted above.

Table 7

Changes in Employment from Tariff Liberalization: Four Major Importing Areas, 1974 Base (excluding petroleum and textiles), 1,000 Jobs (excludes employment from respending effect)

Tariff Formula	Job Loss from Increased Imports Direct A	Job Loss from Increased Imports Total B	Job Gain from Increased Exports Direct C	Job Gain from Increased Exports Total D	Net Balance Direct C − A	Net Balance Total D − B
I. United States						
1.	65.2	140.7	84.0	169.6	18.8	28.9
2	29.8	67.5	40.3	81.6	10.5	14.1
3	66.6	146.2	76.4	154.2	9.8	8.0
4	108.7	234.4	139.0	280.6	30.3	46.2
5	46.8	103.8	60.1	121.5	13.3	17.7
6	27.2	59.6	41.8	85.1	14.6	25.5
7	47.8	103.1	61.8	124.8	14.0	21.7
8	74.4	161.7	88.7	179.0	14.3	17.3
9	39.3	84.1	62.6	127.4	23.3	43.3
10	26.5	158.6	52.9	108.4	26.4	49.8
11	51.1	109.9	71.5	144.8	20.4	34.9
12	41.7	90.2	59.1	119.8	17.4	29.6
II. Canada						
1	37.4	76.2	11.7	25.6	−25.7	−50.6
2	20.7	42.2	4.8	10.8	−15.9	−31.4
3	31.6	64.7	12.2	26.9	−19.4	−37.8
4	62.3	127.0	19.4	42.4	−42.9	−84.6
5	28.0	57.2	8.0	17.7	−20.0	−39.5
6	22.8	46.6	4.4	9.8	−18.4	−36.8
7	27.4	55.9	8.6	18.8	−18.8	−37.1
8	37.8	77.1	13.6	29.9	−24.2	−47.2
9	33.2	67.8	6.7	14.7	−26.5	−53.1
10	29.5	59.4	5.6	12.6	−23.9	−46.8
11	34.6	70.7	9.0	19.7	−25.6	−51.0
12	30.1	61.1	7.1	15.7	−23.0	−45.4
III. Japan						
1	98.4	239.9	101.0	263.8	2.7	23.9
2	57.7	223.9	57.7	142.8	−.1	−81.2
3	86.6	222.0	95.1	254.4	8.5	32.4
4	163.9	399.9	167.5	437.7	3.6	37.8
5	76.9	200.2	79.3	202.6	2.5	2.4
6	59.1	147.4	56.1	138.0	−3.0	−9.4
7	72.0	174.8	74.2	193.9	2.2	19.1
8	101.1	246.1	108.3	287.9	7.2	41.8
9	82.8	200.4	78.5	193.7	−4.3	−6.7
10	29.6	87.9	61.8	152.1	32.2	64.7
11	88.8	218.7	88.2	224.5	−.6	5.8
12	79.0	224.3	75.8	190.1	−3.2	−34.2
*IV. EEC**						
1	91.8		−20.4		−112.2	
2	44.2		−4.4		−39.8	
3	83.4		−11.5		−94.9	
4	153.1		−27.8		−180.8	
5	65.4		−2.2		−67.6	
6	46.5		−4.8		−51.3	
7	71.8		−13.5		−85.3	
8	102.5		−13.6		−116.1	
9	75.8		−15.2		−91.0	
10	35.8		15.0		−20.8	
11	84.5		−16.0		−100.5	
12	70.8		−9.0		−79.8	

*Note that results for the EEC refer to employment effects of all trade changes including reduced imports from, and exports to, EEC partner countries. Negative entries in column C indicate that reduced export jobs for exports to partners outweigh increased export jobs for increased exports to outsiders (excluding exports through the respending effect).

For the EEC, estimates of total job effects (including indirect jobs) are unavailable.

Table 8

United States: Trade and Employment Effects by Product Groups: 60 percent Tariff Cut Case (1971 Base; $millions and 1,000 jobs)

BTN Section	Trade			Direct Jobs			Net Jobs as Percent of Sectoral Employment
	Imports	Exports	Balance	Imports	Exports	Balance	
1 Animal products	18.3	8.6	−9.7	0.5	0.2	−0.3	n.a.
2 Vegetable products	21.3	33.5	12.2	1.1	1.7	0.6	n.a.
3 Fats, oils	2.8	8.1	5.3	0.1	0.2	0.1	n.a.
4 Food, beverages, tobacco	152.5	50.0	−102.5	3.8	2.1	−1.7	−0.10
5 Mineral products*	2.1	19.0	17.0	0.1	0.6	0.5	0.14
6 Chemicals	45.1	215.6	170.5	0.9	4.2	3.3	0.31
7 Plastics, rubber	324.5	147.1	−177.4	3.9	3.3	−0.5	−0.09
8 Hides, leather	54.9	5.8	−49.2	3.9	0.4	−3.5	n.a.
9 Wood, cork products	25.6	10.0	−15.6	1.1	0.5	−0.7	−0.15
10 Paper products	7.8	78.9	71.1	0.3	2.5	2.2	0.35
11 Textiles	831.4	113.0	−718.4	41.6	4.6	−37.0	−1.65
12 Shoes, hats	73.0	2.6	−70.4	4.1	0.2	−3.9	n.a.
13 Non-metallic minerals	37.8	27.4	−10.4	1.5	1.1	−0.4	−0.07
14 Jewelry	45.5	3.2	−42.3	1.8	0.1	−1.7	n.a.
15 Base metals	319.6	143.8	−175.8	8.9	[illegible]	−4.4	−0.18
16 Machinery, electrical equipment	160.8	657.6	496.8	5.8	22.7	16.9	0.49
17 Transportation equipment	251.2	190.4	−60.8	5.9	5.9	0.0	0.00
18 Precision instruments	99.9	146.6	46.7	3.8	5.4	1.6	n.a.
19 Arms	7.8	2.2	−5.6	0.2	0.1	−0.2	n.a.
20 Miscellaneous including furniture	76.9	37.4	−139.5	8.0	1.6	−6.4	n.a.
21 Art	0.1	0.0	−0.1	0.0	0.0	0.0	n.a.
Total excluding oil	2658.8	1900.8	−758.0	97.3	61.8	−35.6	
Total excluding oil & textiles	1827.4	1787.8	−39.6	55.7	57.2	1.4	
Manufacturing excluding textiles†	1630.4	1668.6	38.2	50.1	52.4	2.3	

*Excludes oil.
†Excludes sections 1–5, 11.

These sectoral estimates refer to results computed using the 1971 data base without subsequent updating to 1974.[25] These results, for a 60 percent tariff cut, refer to direct jobs only — because our coefficients for indirect job changes caused by trade change in a given sector do not distribute the changes across product sectors.

Table 8 indicates that if textiles (BTN section 11) were included in liberalization there would be a substantial concentration of jobs lost to imports in that sector, approximately 42,000 jobs out of a total of 97,000. However, textiles trade is unlikely to be liberalized; and even if it were, the estimated reduction of jobs due to increased imports would be only about 2 percent of U.S. employment in the textile sector. A relatively less costly adjustment would seem feasible if liberalization were phased in over a period of years.[26] In other sectors, employment effects would be much more limited. The most important sectoral effect outside of textiles appears to be the potential for sizable export job gains in the machinery sector (BTN section 16).

The final column in Table 8 presents estimates of direct job changes as a percentage of sectoral employment.[27] For the sectors in which estimates are possible, our conclusion of limited employment effects is borne out at the sectoral level as well as at the aggregate level. As shown in Appendix Tables B-1 through B-3, the same conclusion holds for Canada, Japan, and the EEC.

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[25] The labor estimates for 1974 in Table 7 apply single overall expansion factors to estimated labor effects for 1971; our only available employment estimates at the sectoral level are for 1971.

[26] In 1971 the United States had approximately 2.2 million workers in the textile and wearing apparel sectors (SIC 321 and 322) [21, p. 575].

[27] For details on data and sectoral correspondences, see [8].

5. Conclusion

The central conclusion of this study is that trade liberalization in the Tokyo Round of multilateral trade negotiations can achieve significant welfare gains through freer trade with no serious threat of either trade balance deterioration or employment dislocation.

For the industrial countries as a whole the once-for-all value of total welfare gains is estimated at $170 billion (in 1974 values) under the more liberalizing tariff cuts being considered. The figures would be much higher if textiles were liberalized (gain for the United States would double) [8, chap. 3], but the regime of voluntary export quotas controlling trade in this sector is unlikely to be changed in the Tokyo Round.

Among the four major parties in the negotiations, liberalization would tend to increase the trade balance for Japan and the United States and reduce it for Canada and the EEC.

For the United States liberalization is estimated to improve the trade balance primarily by opening markets in Canada and the EEC, with the opportunity to replace "partner supply" behind the tariff wall of the EEC. Japan's estimated trade balance gains appear to come from the country's strong competitive position generally, and the gains tend to be greater for the more liberalizing tariff-cutting formulas. It is estimated that Canada would tend to experience a trade balance reduction from liberalization, because the country has relatively high tariffs on dutiable trade, and because foreign markets opened by tariff reduction tend to be for manufactured goods whereas Canada's exports are concentrated in agricultural goods and raw materials. For the EEC, the source of estimated trade balance deterioration from liberalization is the substitution effect, through which supply from partners is replaced by supply from countries outside the free-trade bloc as the external tariff wall declines, and the relatively high incidence of EEC import increases from "rest of world" countries not reducing their own tariffs. Despite these patterns, all trade balance change estimates are small and in our opinion would not constitute grounds for opposing liberalization.

Detailed examination of twelve separate tariff-cutting formulas indicates that the U.S. and Canadian approaches would both create approximately twice as much new trade as the more restrictive EEC and Japanese approaches. Based on criteria of trade balance effect and percentage change in exports relative to that in imports, both the EEC and Canada would do best under their own respective proposals. The U.S. proposal reflects somewhat greater weight on welfare gains than on trade effect objectives. Ironically, according to our calculations Japan would do poorly on either welfare or trade effect criteria under its own formula because of the restrictiveness of that formula. When the tariff formulas considered are ranked jointly for the four major negotiating areas, taking both trade effect and welfare rankings into account, the result is that the negotiators would do best overall by adopting full U.S. tariff cutting authority (60 percent tariff cut and the elimination of tariffs 5 percent and lower). The second best formula for all parties jointly is a new harmonization formula explored in this study (the percent cut in the tariff equals 20 percent plus three times the tariff, subject to a maximum cut of 60 percent). That formula has the pragmatic advantage that it lies in between the EEC and the U.S. positions in the negotiations to date.

The exchange rate effects of tariff liberalization, like trade balance effects, would be extremely small. At the aggregate level, job changes from liberalization would also be small. Even in the most sensitive sector in the United States, textiles, liberalization would reduce employment by less than 2 percent and the phasing-in period would provide time for adjustment. At present, it is unlikely that textiles tariffs will be liberalized.

Our broader study of the Tokyo Round yields other important policy conclusions [8]. In a linear programming analysis of tariff cuts, maximizing welfare gains subject to trade balance reduction constraints, we obtain results reinforcing the conclusions above: thoroughgoing liberalization would be optimal even with stringent trade balance constraints.

The broader study includes an examination of the impact of the Tokyo Round on the developing countries. This analysis indicates that deep liberalization on a most-favored-nation basis would confer sizable export gains on the developing countries. By contrast, any corresponding loss of exports caused by an erosion of tariff preferences would be minimal, in view of the restrictions on preference schemes. (A similar conclusion is reached in [4].)

In the area of nontariff barriers, our broader study applies tariff-cutting formulas to the tariff equivalents of agricultural variable levies in Europe and quotas in Japan. The resulting estimates indicate that increased trade from the liberalization of these barriers would be important, but considerably less so than commonly thought, raising the policy question of the wisdom of immobilizing the whole set of Tokyo Round discussions because of disagreement among parties in the area of agricultural nontariff barriers. In particular, a 60 percent cut in the tariff-equivalents of agricultural nontariff barriers (NTBs) would raise EEC imports from nonmember countries by an esitmated $1.9 billion, whereas a 60 percent cut in tariff protection (mainly on industrial goods) would raise the Community's external imports by $4.5 billion (1974 values). Similarly, for Japan agricultural NTBs are less significant than tariffs; the corresponding import effects would be $280 million and $1.7 billion respectively. Measured by static welfare effects, agricultural nontariff barriers are more important because of their very high tariff-equivalents. Of total welfare gains from a 60 percent cut in tariffs and in tariff equivalents of agricultural NTBs, the agricultural barriers would provide one-third of the gains for Japan and 80 percent of gains for Europe. Finally, for exports of the United States and Canada, agricultural NTBs would be of less importance than tariff liberalization on industrial and agricultural products. Agricultural exports due to a 60 percent cut in tariff equivalents of NTBs would represent only 13 percent of total U.S. export increases from tariff and agricultural NTBs liberalization together; for Canada, the corresponding figure is 37 percent.

Another NTB examined in the broader study is discrimination in government procurement. Based on studies by other authors [2, 16], we estimate that the removal of government discrimination would raise U.S. imports by approximately $1 billion and those of the EEC by $550 million in 1974 values. Although significant, these effects are considerably smaller than those resulting from tariff liberalization.

In sum, the estimates of this study indicate that relatively deep cuts in tariffs and nontariff barriers (such as the full U.S. authority — 60 percent cut with elimination of protection below 5 percent) could provide important welfare gains to consumers in industrial countries as well as important export gains to developing countries. These potential gains would be approximately cut in half if, instead, negotiators adopted the more restrictive tariff-cutting formulas under active consideration in the negotiations, and would be still further reduced if major areas such as agricultural NTBs were omitted from liberalization. The impact of liberalization on "labor displacement" would be inconsequential. Any prospective trade balance losses for individual countries from even the most liberal tariff-cutting formulas would be extremely modest and would not constitute the basis for limiting the extent of liberalization.

For these reasons it would appear incumbent upon negotiators in the Tokyo Round to move quickly towards agreements very substantially reducing the remaining structure of tariff and nontariff barriers to trade. Their failure to do so would not only sacrifice important potential gains for consumers and for productive efficiency and progress in limiting inflation in industrial countries, as well as the export hopes of developing countries; but would also run the risk of an eventual retrogression towards increased rather than reduced protection, as the continuing irritations inherent in areas of potential dispute (especially in NTBs) threatened to spread to other areas of trade policy.

Appendix A

Elasticities

Table A-1 lists the empirical sources used for the import elasticities applied in the model of tariff negotiations. The EEC elasticities are averages of member country elasticities with weights proportional to member country imports from nonbloc sources. Table A-2 reports the resulting price elasticities of imports for each area, by BTN section, and overall. For the elasticity of substitution, σ, we used the value -2.5, based on various sources (especially [15]).

Table A-2 shows in the final column EECX the price elasticity of EEC imports from nonbloc suppliers. This elasticity reflects the combined influence of the import elasticity regardless of source and the substitution elasticity for shifts from bloc to nonbloc suppliers.

Table A-1

Sources for Estimates of Import Elasticities

Country	Source (by order of preference)
United States	Kreinin; Almon-Buckler; Taplin
Canada	Taplin
Japan	[8, Appendix C]; Taplin
EEC:	
United Kingdom	Barker; Taplin
France	Kreinin; Taplin
Germany	Glismann; Taplin
Others	Taplin
Austria	Taplin (nonzero); Germany/Glismann; Germany/Taplin
Finland	Taplin; Sweden/Taplin
Norway	Kreinin; Taplin
Sweden	Kreinin; Taplin
Switzerland	Taplin
Australia	New Zealand/Taplin
New Zealand	Taplin

Sources: Clopper Almon, Jr., Margaret Buckler, Lawrence Horwitz, Thomas Reimbold, 1985: *Interindustry Forecasts of the American Economy*. (Lexington, Mass.: D.C. Heath, 1974). Terence Barker, *The Determinants of Britain's Visible Imports: 1949–1966*. (Cambridge: University of Cambridge, Department of Applied Economics, 1970). Hans H. Glismann, *Die Gesamtwirtschaflichen Kosten der Protektion*. Kiel Discussion Papers No. 35. (Kiel: Institut fur Weltwirtschaft, 1974). Mordechai E. Kreinin, "Disaggregated Import Demand Functions-Further Results," *Southern Economic Journal*, Vol. 40, No. 1 (July 1972), 19–25. Taplin estimates: published in R. J. Ball, *The International Linkage of National Economic Models*. (Amsterdam: North-Holland Publishing Co., 1973).

Table A-2

Weighted Average Price Elasticity of Imports by Product and Importing Area

BTN section	USA	CAN	JPN	EEC	ATA	FIN	NOR	SWD	SWZ	ALA	NWZ	EECX
1 Animal products	−0.53	−0.84	−1.13	−0.50	−0.55	−0.09	−0.56	−0.47	−0.15	−1.12	−1.62	−1.09
2 Vegetable products	−0.90	−0.85	−0.47	−0.52	−0.58	−0.20	−0.70	−0.45	−0.16	[illegible]	−1.13	−0.89
3 Fats, oils	−0.43	−2.30	−0.62	−0.57	−0.41	−0.95	−1.00	−0.70	−0.69	−1.65	−1.51	−1.26
4 Food, beverages, tobacco	−1.13	−0.76	−0.58	−0.56	−0.60	−0.09	−0.82	−0.41	−0.17	−1.12	−1.12	−1.02
5 Mineral products*	−0.22	−1.81	−1.59	−0.96	−0.56	−0.99	−1.27	−0.26	−1.41	−1.44	−1.68	−2.07
6 Chemicals	−0.97	−2.07	−1.37	−0.96	−0.72	−0.98	−0.50	−0.90	−1.05	−1.22	−1.23	−2.50
7 Plastics, rubber	−3.57	−2.13	−2.96	−1.32	−0.74	−0.99	−0.72	−1.11	−0.90	−1.24	−1.23	−3.25
8 Hides, leather	−2.46	−2.07	−1.32	−1.09	−0.74	−0.99	−2.61	−4.38	−0.97	−1.23	−1.23	−2.33
9 Wood, cork products	−0.96	−2.14	−1.33	−0.83	−0.57	−0.99	−2.47	−1.53	−0.61	−1.62	−1.64	−2.09
10 Paper products	−1.44	−2.07	−1.74	−0.79	−0.70	−0.99	−2.80	−1.29	−0.85	−1.27	−1.23	−2.60
11 Textiles	−2.43	−2.09	−1.56	−1.07	−0.74	−0.99	−1.99	−2.09	−0.95	−1.24	−1.23	−2.61
12 Shoes, hats	−1.23	−2.07	−1.42	−1.27	−0.74	−0.99	−2.53	−5.73	−1.05	−1.23	−1.23	−2.77
13 Nonmetallic minerals	−1.37	−2.07	−1.42	−1.20	−0.74	−0.99	−0.89	−1.60	−1.05	−1.23	−1.23	−3.17
14 Jewelry	−3.77	−2.07	−0.99	−1.21	−0.74	−0.99	−2.80	−1.31	−0.57	−1.24	−1.48	−2.64
15 Base metals	−1.99	−2.07	−2.36	−1.47	−0.74	−0.99	−1.85	−1.31	−1.05	−1.23	−1.23	−3.25
16 Machinery, electrical equipment	−0.87	−2.07	−1.78	−0.92	−0.74	−0.99	−3.51	−1.27	−1.05	−1.23	−1.23	−2.63
17 Transportation equipment	−2.53	−2.07	−1.87	−1.15	−0.74	−0.99	−1.03	−1.27	−1.05	−1.23	−1.23	−2.43
18 Precision instruments	−1.70	−2.07	−2.22	−1.26	−0.74	−0.99	−1.89	−4.72	−1.05	−1.23	−1.23	−2.79
19 Arms	−3.02	−2.07	−1.42	−1.75	−0.74	−0.99	−2.80	−4.50	−1.05	−1.23	−1.23	−3.56
20 Miscellaneous including furniture	−4.44	−2.07	−1.42	−1.38	−0.74	−0.99	−2.80	−5.80	−1.05	−1.23	−1.23	−3.00
21 Art	−3.02	−2.07	−1.42	−2.45	−0.74	−0.99	−0.50	−5.80	−1.05	−1.23	−1.23	−4.77
TOTAL	−1.85	−1.94	−1.39	−0.92	−0.65	−0.61	−1.72	−1.50	−0.69	−1.24	−1.23	−2.17

Source: see Table A-1.

NOTE: Weighted by value of imports (from suppliers outside bloc, for EEC and EFTA) by 4-digit BTN sector. Column EECX imports from outside bloc after including substitution effect.

*Excludes oil.

Appendix B

Sectoral Employment Effects: Canada, Japan, EEC

Table B–1

Canada: Trade and Employment Effects by Product Groups 60 Percent Tariff Cut Case (1971 Base)

BTN Section	Trade ($millions)			Direct Jobs (thousands)			Net Jobs as Percent of Sectoral Employment
	Imports	Exports	Balance	Imports	Exports	Balance	
1 Animal products	3.6	6.1	2.6	0.1	0.2	0.1	n.a.
2 Vegetable products	7.7	13.4	5.7	0.4	0.7	0.3	n.a.
3 Fats, oils	4.4	1.7	−2.7	0.1	0.0	−0.1	n.a.
4 Food, beverages, tobacco	25.7	29.0	3.3	0.6	0.8	0.2	0.09
5 Mineral products*	1.2	1.5	0.3	0.0	0.0	0.0	0.00
6 Chemicals	60.0	12.7	−47.3	1.2	0.3	−0.9	−1.15
7 Plastics, rubber	57.9	33.7	−24.2	1.2	0.5	−0.7	−1.56
8 Hides, leather	11.5	3.8	−7.8	0.8	0.3	−0.6	n.a.
9 Wood, cork products	10.6	13.6	3.0	0.5	0.7	0.2	0.22
10 Paper products	28.8	32.7	3.9	1.1	1.0	−0.1	−0.08
11 Textiles	163.2	24.7	−138.5	7.0	1.2	−5.8	−2.93
12 Shoes, hats	22.9	1.7	−21.2	1.5	0.1	−1.4	n.a.
13 Nonmetallic minerals	26.2	3.7	−22.5	1.1	0.2	−0.9	−1.73
14 Jewelry	3.1	0.5	−2.6	0.1	0.0	−0.1	n.a.
15 Base metals	106.5	72.3	−34.2	3.5	1.5	−2.1	−0.88
16 Machinery, electrical equipment	271.9	40.9	−231.0	9.7	1.5	−8.2	−3.90
17 Transportation equipment	117.5	33.3	−84.2	3.0	1.1	−1.9	−1.27
18 Precision instruments	40.3	9.9	−30.3	1.5	0.4	−1.1	n.a.
19 Arms	1.8	1.3	−0.5	0.1	0.0	−0.0	n.a.
20 Miscellaneous including furniture	28.0	13.5	−14.5	1.3	0.7	−0.6	n.a.
21 Art	0.0	0.0	−0.0	0.0	0.0	−0.0	n.a.
Total excluding oil	992.7	349.9	−642.8	34.7	11.0	−23.6	
Total excluding oil & textiles	829.4	325.2	−504.2	27.7	9.8	−17.9	
Manufacturing excluding textiles †	876.9	273.5	−513.4	26.5	8.1	−18.4	

*Excludes oil.

† Excludes sections 1–5, 11.

Table B–2

Japan: Trade and Employment Effects by Product Groups 60 Percent Tariff Cut Case (1971 Base)

BTN Section	Trade ($millions)			Direct Jobs (thousands)			Net Jobs as Percent of Sectoral Employment
	Imports	Exports	Balance	Imports	Exports	Balance	
1 Animal products	36.6	2.5	−34.1	3.8	0.5	−3.3	n.a.
2 Vegetable products	54.5	0.8	−53.7	33.9	0.1	−33.8	n.a.
3 Fats, oils	1.7	0.4	−1.3	0.0	0.0	−0.0	n.a.
4 Food, beverages, tobacco	92.8	10.6	−82.2	2.3	1.3	−1.0	−0.09
5 Mineral products*	13.7	0.0	−13.7	0.0	0.0	−0.0	0.00
6 Chemicals	61.6	28.4	−33.2	2.8	1.4	−1.4	−0.28
7 Plastics, rubber	18.0	95.5	77.5	1.5	9.9	8.3	1.92
8 Hides, leather	3.3	17.4	14.0	0.5	4.2	3.7	n.a.
9 Wood, cork products	4.0	10.0	6.0	0.4	1.2	0.8	0.13
10 Paper products	9.7	7.8	−1.9	0.4	0.6	0.2	0.06
11 Textiles	45.8	249.7	203.9	6.8	47.5	40.7	2.44
12 Shoes, hats	4.4	22.2	17.8	0.6	4.4	3.8	n.a.
13 Nonmetallic minerals	2.8	28.6	25.8	0.3	5.5	5.2	0.93
14 Jewelry	5.6	5.1	−0.4	0.5	0.6	0.1	n.a.
15 Base metals	70.2	191.7	121.5	3.4	7.9	4.5	0.28
16 Machinery, electrical equipment	170.4	172.3	1.9	10.5	12.0	1.5	0.06
17 Transportation equipment	46.5	201.1	154.6	2.3	9.5	7.2	0.83
18 Precision instruments	38.8	93.0	54.3	4.0	8.8	4.8	n.a.
19 Arms	4.5	1.5	1.0	0.1	0.2	0.1	n.a.
20 Miscellaneous including furniture	18.9	77.4	58.4	2.1	8.7	6.6	n.a.
21 Art	0.0	0.0	0.0	0.0	0.0	0.0	n.a.
Total excluding oil	699.8	1215.8	516.0	76.4	124.4	48.0	
Total excluding oil & textiles	654.0	966.3	312.2	69.6	76.9	7.3	
Manufacturing excluding textiles†	454.7	951.8	497.1	29.6	75.0	45.4	

*Excludes oil.
†Excludes sections 1–5, 11.

Table B–3

EEC: Trade and Employment Effects by Product Groups 60 Percent Tariff Cut Case (1971 Base)

BTN Section	Trade ($millions)			Direct Jobs (thousands)			Net Jobs as Percent of Sectoral Employment
	Imports	Exports	Balance	Imports	Exports	Balance	
1 Animal products	32.8	−26.1	−58.9	3.5	−4.6	−8.1	n.a.
2 Vegetable products	114.5	−71.1	−185.6	20.9	−17.7	−38.6	n.a.
3 Fats, oils	16.8	−19.0	−35.8	0.5	−0.6	−1.1	n.a.
4 Food, beverages, tobacco	115.9	−31.4	−147.3	3.2	−0.7	−3.8	−0.16
5 Mineral products*	13.5	−14.5	−28.0	1.4	−1.5	−2.9	−0.31
6 Chemicals	99.6	−60.2	−159.8	4.0	−2.4	−6.4	−0.34
7 Plastics, rubber	63.9	123.9	60.0	3.0	10.6	7.5	0.78
8 Hides, leather	13.3	2.6	−10.7	1.1	0.2	−0.9	n.a.
9 Wood, cork products	20.4	−9.1	−29.5	1.4	−0.6	−2.0	−0.28
10 Paper products	31.8	−16.4	−48.2	1.9	−0.9	−2.8	−0.33
11 Textiles	171.0	−5.8	−176.9	15.8	−1.2	−17.1	−0.49
12 Shoes, hats	20.5	7.6	−12.9	2.1	0.9	−1.2	n.a.
13 Nonmetallic minerals	16.5	5.0	−11.5	1.1	0.3	−0.8	−0.06
14 Jewelry	2.6	20.5	17.9	0.2	1.4	1.3	n.a.
15 Base metals	107.3	34.2	−73.1	5.7	2.0	−3.7	−0.09
16 Machinery, electrical equipment	180.5	−92.7	−273.2	11.9	−6.2	−18.0	−0.28
17 Transportation equipment	79.9	87.1	7.1	4.7	5.1	0.4	0.01
18 Precision instruments	77.8	−23.0	−100.8	6.6	−1.9	−8.5	n.a.
19 Arms	1.2	3.5	2.3	0.1	0.2	−0.2	n.a.
20 Miscellaneous including furniture	30.9	12.9	−18.0	2.1	0.9	−1.2	n.a.
21 Art	0.0	0.1	0.1	0.0	0.0	0.0	n.a.
Total excluding oil	1210.8	−72.2	−1283.1	91.1	−16.6	−107.8	
Total excluding oil & textiles	1039.7	−66.4	−1106.1	75.3	−15.4	−90.7	
Manufacturing excluding textiles†	746.2	125.7	−620.5	45.8	9.7	−36.1	

*Excludes oil.

†Excludes sections 1–5, 11.

Literature Cited

1. Balassa, Bela, ed. *European Economic Integration*. Amsterdam: North-Holland/American Elsevier, 1975.
2. Baldwin, Robert. *Nontariff Distortions of International Trade*. Washington, D.C.: Brookings Institution, 1970.
3. ______. "Trade and Employment Effects in the United States of Multilateral Tariff Restrictions." Mimeographed. Washington, D.C., 1975.
4. Baldwin, Robert, and Tracy Murray. "MFN Tariff Reductions and Developing Countries' Trade Benefits under the GSP." *Economic Journal*, 87 (March 1977), 30–46.
5. Baldwin, Robert, and Jack Mutti. "Policy Issues in Adjustment Assistance: The United States." In *Prospects for Partnership: Industrialization and Trade Policies in the 1970s*, edited by Helen Hughes, pp. 149–77. Baltimore: Johns Hopkins University Press, 1973.
6. Chamber of Commerce of the United States, International Group. *Trade Negotiations Information Service Bulletin No. 2*. Washington, D.C., 1976.
7. ______. *Trade Negotiations Information Service Bulletin No. 5*. Washington, D.C., 1976.
8. Cline, William R., Noboru Kawanabe, T.O.M. Kronsjo, and Thomas Williams. "Trade, Welfare, and Employment Effects of Multilateral Trade Negotiations in the Tokyo Round." Mimeographed. Washington, D.C.: Brookings Institution, 1976.
9. Deardorff, Alan, Robert Stern, and Christopher Baum. "A Multi-Country Simulation of the Employment and Exchange Rate Effects of Post-Kennedy Round Tariff Reductions." University of Michigan, Research Seminar in International Economics, Discussion Paper No. 68, 1976.
10. Evans, John W. *The Kennedy Round in American Trade Policy: The Twilight of the GATT?* Cambridge, Mass.: Harvard University Press, 1971.
11. GATT. *Basic Documentation for the Tariff Study: Summary by Industrial Product Categories*. Geneva, March 1974.
12. International Monetary Fund. *International Financial Statistics*. Monthly. Washington, D.C.: IMF, 1976.
13. Johnson, Harry G. "An Economic Theory of Protectionism, Tariff Bargaining, and the Formation of Customs Unions." *Journal of Political Economy*, 73 (June 1965), 256–83.

14. *Journal of Commerce*. "Quest for Worldwide Formula to Cut Tariffs Resumes Soon." July 2, 1976.
15. Kravis, Irving, and Robert Lipsey. *Price Competitiveness in World Trade*. New York: Columbia University Press, 1971.
16. Lowinger, Thomas. "Discrimination in Government Procurement of Foreign Goods in the United States and Western Europe." Mimeographed. Pullman: Washington State University, 1973.
17. Meade, James. *The Theory of International Economic Policy. Vol. I: The Balance of Payments*. London: Oxford University Press, 1951.
18. O.E.C.D. *Labour Force Statistics: 1962–1973*. Paris: O.E.C.D., 1975.
19. ———. *Trade by Commodities: Schedule B, 1974*.
20. Preeg, Ernest H. *Traders and Diplomats*. Washington, D.C.: Brookings Institution, 1970.
21. United Nations. *The Growth of World Industry: 1973 Edition, Vol. I*. New York: United Nations, 1975.
22. *Wall Street Journal*. "Common Market Proposes Tariff Cuts but U.S. Delegates Call Formula 'Puny.'" July 8, 1976.

Comment

Anne O. Krueger

The Cline-Kawanabe-Kronsjo-Williams (CKKW) paper presents the results of an investigation of the implications of alternative tariff-cutting formulas. To accomplish this, the authors use detailed, line-item tariff data in the context of a multicountry model. They estimate the tariff cuts that would take place under alternative formulas and combine those estimates with "best available" estimates of demand elasticities for each of the eleven geographic regions (ten countries plus the EEC group) to generate estimates of orders of magnitude of changes in trade flows and other variables in response to each of the formulas.

There is little doubt as to the importance of the research. It represents a distinct improvement in our tool kit and provides information on a complicated subject in which the plethora of detail has heretofore discouraged analysis.

There are two main uses to which the CKKW model and its results can be put. On one hand, the model yields estimates of changes in trade flows for individual commodity groups and countries. I will refer to these commodity-specific results, and the accompanying employment estimates, as the microeconomic features of the model. These uses can be contrasted with the application of the model to estimating aggregate changes in trade balances, exchange rates, and employment levels. These are the macroeconomic aspects of the model. In a nutshell, I find the value and significance of the CKKW model in its microeconomic aspects, and am dubious as to the value of the model for more macroeconomic purposes. I therefore intend to divide my comments into two parts. I wish first to discuss the microeconomic aspects of the model that raise interesting and important questions and point the way for further research. Thereafter, I will explain the basis for my misgivings with regard to the macroeconomic applications of the model.

Turning, therefore, to the microeconomic aspects of the paper, let me first repeat that the CKKW results are of great significance. I have no quarrel with their findings with respect to alternative tariff cutting rules. My comments in this regard, therefore, are directed toward further uses to which the model could be put.

A first point is that the model devised by CKKW is highly complex, entailing data on about five thousand line-item tariffs for each of eleven regions, and employing separate demand elasticity estimates in each case. In view of the expense of running such a large model, I would have hoped that CKKW could have shed some light on two questions. First, to what extent are the estimates of trade and employment effects, taking all eleven together, significantly different from the estimates obtained when considering a single country at a time? That is, to what extent is the additional complexity of the model resulting from its simultaneous treatment of all eleven countries warranted in terms of increasing information about the properties of alternative tariff cuts? Here, I have in mind Baldwin's model discussed in his conference paper with Lewis as an alternative. Baldwin was able to concentrate in greater detail on various aspects of U.S. markets. In so doing, there is both a gain and a loss in information. I would hope that CKKW could shed some light on the sorts of questions for which a multicountry model is better suited.

The second question applies to the extent to which disaggregation of the tariff rates alters the results. The problem is rather more complicated than the one "bias" discussed by CKKW. They point out, correctly, that use of tariff averages may well obscure the implications of alternative formulas for tariff cuts. If, for example, one tariff-cutting formula tends to decrease very high tariffs by more, and intermediate tariffs by less, than another formula, application of the two formulas to average tariff rates within commodity groups will conceal some of the differences in results. That much is so. However, CKKW had to use fairly aggregated estimates of demand elasticities (only four different values for Finland, eight for Australia, and so on) and then applied those aggregate elasticities to all the detailed tariff changes. Depending on a variety of factors, one can imagine the bias in the estimated trade change resulting from this procedure as being either larger or smaller than the bias resulting from applying average tariff changes to the aggregate elasticities. Suppose, for example, that high tariff rates within categories occur when the price elasticity of demand is low. The "bias" from using detailed tariff rates could be significant, and worse yet, it might alter the ranking of the estimates of different formulas for cutting tariffs. It would have been useful had the authors attempted some analysis of the nature of the bias implicit in using detailed tariff data with fairly aggregative demand estimates. Perhaps a simulation run, within their model, in which they compute the average tariff change under each formula to the same level of aggregation as their demand elasticities, and contrast the resulting estimates of changes in trade flows with those in which detailed tariff-rate changes are applied, would yield the relevant information. Even that, however, would not get at the problem that the elasticities of demand for different commodities might be significantly different.

Finally, I would have hoped that CKKW would provide more detail on individual commodity results and, in particular, would report on the quantitative significance of indirect trade effects for particular industry groups. Questions of some importance are the extent to which alternative formulas might have smaller "adverse" effects, as measured by the number of industry groups that would experience import increases in excess of particular cut-off numbers.

These sorts of questions pertain to ways in which the usefulness of the model has not yet been fully exploited. They point to additional areas in which the model can yield insights into important questions. By contrast, I am very skeptical as to the value of some of the macroeconomic results obtained from the model.

First, some strenuous objections. It seems totally implausible that demand elasticities — supposed to be partial in nature with real income held constant — can be applied to price changes, and that the resulting estimates can be summed to yield any insight into the net change in the trade balance. Worse yet is the effort to estimate the necessary change in the exchange rate required to compensate for the presumed trade balance effects. Determinants of both the trade balance and the exchange rate are basically macroeconomic in nature, and summation of results from microeconomic demand relations is a fundamentally fallacious procedure.

The difficulty with it is illustrated — in only one of many possible ways — by recognizing that CKKW obtained their estimates of trade balance shifts by assuming that the marginal propensity to spend of the industrialized countries is zero and that of the rest of the world is one. However, when one sums their net trade balance effects, only for one tariff cut — 60 percent (Table 6) — do they give the net trade balance effect for all eleven regions, and it is a negative $1.4 billion. But by their assumptions, the rest of the world has an unaltered net trade account: since trade must balance for the world as a whole, something is surely wrong! Incidentally, if one sums the net trade changes for the four regions listed in Table 3, the net change in trade balance for the four regions is implausibly large for all possible tariff-cutting formulas except the tenth. Indeed, under the full liberalization (alternative 4), the net change for the four is minus $1.5 billion — again implausibly large relative to the economic size of the countries not listed.

Given the meaninglessness of the net change in trade balance estimates, the estimates of changes in exchange rates must anyway be discarded: if one assumed that marginal propensities to spend among the eleven regions were proportional to their expenditure-income relationship in the base year, surplus countries' surpluses would increase and deficit countries' deficits would increase in response to tariff cuts: all that comes out of the model is what goes in, and CKKW have implicitly given the eleven regions a marginal propensity to spend of less than one and have thereby generated a deficit in the world trade balance.[1]

The same sort of reservation applies to the aggregate employment estimates. As already stated, it is useful to attempt to identify the individual industries that will experience increased and decreased demand for their outputs, and consequently shift their demand for labor upward and downward, as a result of tariff cuts. Those estimates can serve to assist policy makers in identifying the regions and sectors of the economy in which problems of adjustment are likely to arise. When, however, the estimated change in employment in individual sectors is summed over the entire economy, it is doubtful whether any significance can be attached to the resulting number. First, there are the reservations already expressed about the means used for estimating trade balance effects — yet those effects dominate the aggregate employment estimates. Second, there are two major classes of macroeconomic models, and in neither can a change in employment be determined in the manner suggested by the CKKW model. In one class of models, there is a "natural rate of unemployment," in which case tariff cuts will leave that rate unaffected. In the other class of models, aggregate demand affects the level of employment. If the "natural rate" hypothesis is correct, estimating an aggregate employment effect is wrong; if aggregate demand affects the level of employment, then monetary and fiscal policy are presumably able to attain the desired employment level.

My misgivings about the aggregate employment figures should not be interpreted to mean that I regard the employment effects of tariff cuts as unimportant; rather, my concern is with the fact that the useful information that can be gleaned from an admittedly partial equilibrium model lies in the insights it provides with respect to the initial impact on particular industries' demand for labor, and not on the aggregate employment effect.

Finally, I find the ranking of benefits arising out of the alternative tariff-cutting formulas useful, and would have been interested to see how those estimates compare with ones derived from more aggregated tariff data, single-country estimation procedures, and so on. However, it is not evident that one can attach any significance to the absolute value of the estimated "areas under the triangle." An attempt to blow up the static estimates by Balassa's ratio for the Common Market mentioned in Cline's paper is suspect on several grounds. First, there are questions as to the reliability of Balassa's estimate itself. Second, there is a major question as to whether even free trade between, e.g., Japan and Australia could yield benefits as large as integration of the European Economic Community simply because distance places natural barriers to greater trade. Third, the EEC provided individuals within its boundaries considerable certainty that there would not be artificial barriers to continued trade between them. Insofar as that sort of certainty is important in terms of whatever "dynamic" benefits there are, those benefits are much less likely to arise from tariff cuts than they are from customs unions, simply because "escape clauses" and other instruments of national policy are less likely to be invoked under the latter. Finally, the EEC arrangement greatly increased the mobility of factors of production among countries, a source of gain that will not be available under the tariff cuts.

I could elaborate other reasons why the macroeconomic estimates arising out of the CKKW model are suspect. However, it is enough to say that the microeconomic strengths of the model are appreciated along with the macroeconomic weaknesses. There are many interesting questions remaining on which the CKKW model can shed light: it is to be hoped that future research by the authors will continue to yield dividends as large as those reported from their initial application of the model.

Literature Cited

1. Pearce, Ivor F. "The Problem of the Balance of Payments." *International Economic Review*, 2 (January 1961), 1–28.

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[1] Their statement that devaluation necessarily implies a deterioration in the terms of trade is incorrect in any event. Although James Meade is the authority on most propositions in international trade, it has long since been recognized that the terms-of-trade change, if any, following a transfer payment (of which devaluation is one form) is a function of the marginal propensities to consume exportables and importables, and *not* of price elasticities. See, for example [1].

Comment

Donald J. Daly

The study by Cline and others is interesting and important with significant policy implications for the trade negotiations currently under way. Two areas of recent research in Canada are relevant to the study and may be of interest.

Simulations of a number of tariff changes for Canada were made by the Economic Council of Canada using the CANDIDE model [2, pp. 166–71]; the employment effects were small, even without compensation, and could be further reduced by offsetting expenditures elsewhere. These results are consistent with the results for this study and the others referred to on the top of page 276 in Cline's paper.

Most studies of tariffs and the costs of tariffs and effects of removing them usually assume constant returns to scale, similar production conditions with and without tariffs, and unchanged input-output coefficients before and after tariffs.

A series of studies indicate that all of these assumptions are inappropriate and misleading for Canada. A key conclusion is that tariffs have a significant effect on production conditions in addition to the usual static costs to the consumer. The presence of tariffs (and nontariff barriers) leads to greater product diversity in a significantly large part of manufacturing. These product specific scale economies are quantitively large, and much larger than the scale economies associated with variations in plant size (the only scale economy usually considered). Under these conditions, differences in output per person can be significantly lower in Canadian than in U.S. manufacturing (even with similar or higher levels of capital stock per person employed in Canadian than in U.S. manufacturing). The levels of output per person in Canadian manufacturing are estimated to be between one fourth and one fifth below the United States levels during the 1970s and labor costs per unit and total costs are normally higher than in the United States. (See [4, esp. parts 2 and 3; 2, chaps. 3, 6; 3, Postscript 1975, pp. 173–87; 1].)

These analyses predict that under free trade (or reduced tariff and nontariff barriers), the productivity and cost differences would narrow appreciably through longer runs of individual commodities and more specialization with increased intraindustry trade. Trade in manufactured products would increase *both ways* with other countries as part of any multilateral reduction, and the ease of adjustment would be heavily influenced by the willingness of Canadian management to change in response to the new trading environment. Changes would occur as the input-output coefficients would change, cost and productivity differences would narrow, and the composition of trade in manufactured products would change significantly. Product specific scale economies would be significant, and production conditions would change in Canada. Changes along these lines have taken place since the initiation of the Kennedy Round reductions and the Canada-United States automotive agreement. Exports of primary products would be less affected as tariff rates are already lower than on manufactured products.

The results of these studies do not seem to have been adequately incorporated into the current study by Cline and others. The study notes that "these calculations exclude effects caused by input-output feedback" (p. 267). Page 276 seems to imply that the same direct and indirect labor coefficients would apply before and after tariff changes. The welfare effects include the static welfare gains (p. 266), but exclude the scale effects that are so significant for Canada. The results for Canada suggest larger trade and employment losses from increased imports.

These results are more in line with the views of those who support the status quo on Canadian tariffs (including some businessmen and union officials) but do not adequately incorporate recent empirical work done on tariffs and their effects on productivity, prices, costs, and international trade. Trade with Canada is sufficiently important that this type of analysis could affect the aggregative results for the United States as well.

Let me illustrate my point with some magnitudes of the real income gains to Canada from a Canada-United States free trade area (a narrower option than formula 4 in this study). Ron Wonnacott estimates the benefits to Canada of a Canada-United States free trade area as 8.2 percent of GNP [3, p. 177]. His estimate would include the effects of increased specialization, higher prices to domestic factors of production on sales to U.S. markets, and increased productivity based on economies of scale. At 1974 levels of GNP, this would amount to about $11.5 billion as a real income gain to Canada, or more than *50 times* the size shown for Canada for formula 4 in Table 4 and almost six times as large as shown for formula 4 in Table 2 for all *eleven* industrial importing areas! Furthermore, the gains to Canada would be somewhat larger if the 100 percent linear cut were extended on a multilateral basis to the other nine industrialized countries, or if other dynamic effects were allowed for. The estimation of static welfare effects to the consumer without allowance for welfare gains from increased specialization and economies of scale leads to a drastic understatement of welfare gains, on the basis of careful empirical work for Canada.

The Economic Council of Canada has also estimated the initial employment effects of a Canada-United States free trade area, without allowing for reorganization of production or depreciation of the Canadian dollar. They estimated the difference in employment as less than 25,000 persons [2, pp. 168, 169], or substantially less than the roughly 85,000 shown for tariff formula 4 in Table 7 for Canada. The effects would be even smaller if the reorganization effects and the associated higher real incomes and declines in prices of manufactured products relative to other prices were allowed for in the form of a longer-term increased demand within Canada for manufactured products. The simulations using the CANDIDE model thus suggest even smaller transitional employment effects without allowing for the longer-term employment effects on demand and supply for manufactured products. The speed and ease of that adjustment will depend critically on the willingness and skills of management in adapting to that new, more competitive environment for manufacturing.

It is hoped that later work in the Brookings project can incorporate these results for Canada more completely.

Literature Cited

1. Daly, Donald J., and Steven Globerman. *Tariff and Science Policies: A Model of Nationalism*. Toronto: University of Toronto Press, 1976.
2. Economic Council of Canada. *Looking Outward: A New Trade Strategy for Canada*. Ottawa: Information Canada, 1975.
3. Wonnacott, Ronald J. *Canada's Trade Options*. Ottawa: Information Canada, 1975.
4. Wonnacott, Ronald J., and Paul Wonnacott. *Free Trade between the United States and Canada, The Potential Economic Effects*. Cambridge, Mass.: Harvard University Press, 1967.

Reply

William R. Cline

Although I am delighted that Anne Krueger considers our study to be of "great significance," her misgivings about the macroeconomic estimates puzzle me. No one would disagree that "determinants of both the trade balance and the exchange rate are basically macroeconomic in nature. . . ." But I disagree that for this reason one should ignore the trade balance or exchange rate "impact effects," viewed as deviations from the main paths determined by macroeconomic forces, when examining the use of a policy instrument such as trade liberalization. Kreuger implies that even the macro impact effect cannot be estimated by "summation of results from microeconomic demand relations. . . . " Apparently Harry Johnson disagrees with this critique. He accepts as legitimate the corresponding macro impact effects estimated by Baldwin and Lewis (using similar methods), although he suggests they could go further and add multiplier and other induced effects.[1] Krueger's "hands off" approach to macro estimates would leave policy makers adrift; rigorous adherence to her approach would preclude saying whether liberalization in the Tokyo Round would have a greater or lesser effect upon trade balances than, for instance, the OPEC oil price increase. Yet an important conclusion that emerges from our study as well as from the study by Baldwin and Lewis is that trade balance impacts from liberalization would be minor and should not stand in the way of thoroughgoing liberalization. Some might be prepared to throw out this crucial policy conclusion because of supposed but unmeasured macroeconomic influences; we are not.

Krueger's acceptance of our micro results is gratifying, although it raises other questions. If the microeconomic estimates are acceptable, why isn't their sum? Presumably Krueger means that the micro results are accurate in relative terms — the machinery sector's trade balance would rise and the textile sector's trade balance would decline — but not in absolute terms because of offsetting influences of macro policy. Moreover, if Krueger is concerned about biases caused by applying broader aggregate elasticities to more detailed commodity classes, it is not clear why she considers the micro estimates to be useful.

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[1] I would argue that the initial impact effects are more meaningful for purposes of policy formulation than estimates that take account of induced multiplier and other secondary effects, since the latter estimates can include a whole variety of outcomes depending on policy responses.

As for disaggregation and elasticities, experiments with individual commodity groups suggest that disaggregation is important in practice as well as in principle. Even when going from the tariff line level to the four-digit Brussels Tariff Nomenclature level, which is still quite disaggregated, the preaggregation of trade and tariff data causes an understatement of approximately 10 percent in the estimated import increases under the EEC harmonization tariff cutting formula (for selected sectors examined in the case of the United States). As for Krueger's comment that at the level of individual commodities there may be biases that are caused by the use of more aggregative elasticities, we can say only that we agree with Krueger's statement that there is no a priori reason to expect such biases to be in any one direction, so that we could expect the results after correction for any such biases (if correction were possible) to be, on the average, the same as our estimates.

Krueger is correct in observing that the aggregate trade balance effect for liberalizing countries is negative. This result reflects the fact that part of the increased export earnings of nonliberalizing "free rider" countries would not return immediately in the form of extra imports from the liberalizing countries. The leakage in our estimated "respending effect" exports occurs because outsider countries spend some of their extra foreign exchange outside of the eleven liberalizing areas. Most analyses of tariff negotiations do not even capture a part of the respending effect; in contrast, Krueger's comments imply that we should have forced the respending effect to exclude any leakage whatsoever. If this change were introduced, the results would show a rise in the trade balance increases estimated for Japan and the United States and a reduction in the trade balance declines computed for Canada and the EEC, but no change in the qualitative results by country or by tariff formula (as indicated in the note to the text). In any event, whether the trade balance impact estimate is more accurate with or without leakage in the respending effect is a moot point. We consider the method in the main text to be more realistic than the alternative of completely eliminating leakage, since that elimination would require a long period of successive respending rounds (i.e., eventually the foreign exchange spent in outsider countries would be respent, after successive rounds, on imports from the liberalizing countries).

Finally, Krueger criticizes our estimate of total welfare gains based on Balassa's results for European integration, although she proposes no alternative method. Once again the question is whether the analyst more faithfully discharges the responsibilities inherent in policy analysis by disclaiming the possibility of making any estimate whatsoever, or by arriving at the best possible estimate given the state of the art. We opt for making the best possible estimate, especially since, in this case, to do otherwise leaves the false impression that trade liberalization simply may not be worth the effort — an impression protectionists would seize upon with alacrity.

Daly's comments are helpful in qualitative terms but misleading with respect to magnitudes. Wonnacott's estimate of 8.2 percent of Canadian GNP as the welfare gain from a free trade area with the United States appears to be seriously exaggerated [3, pp. 177–78]. The estimate is based on the assumption that the removal of trade barriers would raise output per worker throughout the entire Canadian manufacturing sector to the higher levels (by approximately one-fourth) found in the United States. Gains from economies of scale through longer production runs are cited as the prime source of the productivity increase. However, the leap in productivity is assigned to the entire existing industrial park rather than to increased production associated with increased exports; and instead of applying sectoral estimates of returns to scale parameters to sectoral specific estimates of increased output volume, the study assumes productivity in all sectors would rise to U.S. levels. Moreover, except for a modest reduction in estimated liberalization gains from earlier estimates relative to 1963 (because automobile trade has since been liberalized), the method fails to specify a relationship of productivity gain to tariff levels. It is difficult on the face of it to see how the elimination of industrial tariffs averaging 14 percent (7 percent if nondutiable items are included) [2] can raise productivity in the manufacturing sector by one-fourth (or by 7 percent, for that matter). Indeed, the one available study relating Canadian sectoral productivity relative to that in the United States to sectoral protection levels finds no significant relationship, casting doubt on the entire approach. (Study by West, cited in [1, p. 25].)

Our own estimates of total welfare gain (which *do* include scale economies, despite Daly's reference only to our more restricted static estimates) follow the more realistic assumption that gains from economies of scale and new investment would be strictly linked to the magnitudes of increased trade.[3] As for job changes, I do not consider the discrepancy between our figure and that cited by Daly to be particularly important, especially considering that the results for a U.S.-Canadian free trade area should be expected to give smaller import increases for Canada than the elimination of tariffs facing all suppliers (in particular, the U.S. share is only 61 percent of increased Canadian imports in our tariff elimination case). Instead, I interpret the estimates cited by Daly as confirming the general order of magnitude of our own employment estimates. I agree with the direction of Daly's comments: gains for Canada would probably be greater than those estimated by the standard formulations, because of (a) the greater relative importance of achieving economies of scale in Canada than in the larger markets of the United States and Europe, and (b) the stimulus to exports of processed manufactured goods (instead of raw materials) resulting from reduction in effective protection, a phenomenon not captured in our early analysis using nominal tariffs.

Literature Cited

1. Daly, Donald J., and S. Globerman. *Tariff and Science Policies: Applications of a Model of Nationalism*. Toronto: University of Toronto Press, 1976.
2. General Agreement on Tariffs and Trade. *Basic Documentation for the Tariff Study: Summary by Industrial Product Categories*. Geneva: GATT, 1974.
3. Wonnacott, Ronald J. *Canada's Trade Options*. Ottawa: Economic Council of Canada, 1975.

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[3] Our application of the five-to-one relationship of total to static welfare gains would in fact tend to overstate Canadian gains from the standpoint that increased economies of scale and increased investment would be related to additional exports, and Canada's exports rise by considerably less than imports in our results (and, therefore, by relatively small amounts compared to static welfare gains, which are based on import increases).

Trade Impact Studies Using the Wharton Annual and Industry Forecasting Model

Lawrence R. Klein*

The Wharton Annual and Industry Model is a large-scale equation system that attempts to analyze both the supply and demand sides of the economy simultaneously. It differs from much of input-output analysis in that final demand and value added cannot be determined separately and used to generate interindustry flows in the economy. Intermediate flows are endogenous from the point of view of the standard version of a macromodel of entries in the National Income and Product accounts. At the same time, the final demand and value added accounts are endogenous from the point of view of the standard version of an input-output system. Both are interdependent with market equations for the formation of prices, wage rates, and interest rates.

A further, important characteristic of the Wharton Model is that input-output coefficients are not regarded as *parameters* in this system; they are variables. The input-output matrix is not treated as constant, nor even as parameters that may undergo occasional change, exogenously imposed on the basis of a priori engineering, institutional, or general social information. The I-O coefficients are endogenously generated within the model, principally as functions of relative price change.[1]

A graphical layout of the accounting scheme is given in Figure 1, where the intermediate flows among sectors are juxtaposed to final demand (the expenditure side of the National Income and Product Accounts system) and to value added (the income side of the NIPA system).

The standard equation, in matrix form, for input-output systems is written as

$$(I-A)X = F.$$

The matrix A is based principally on the cell entries in the intermediate transactions portion of Figure 1.

$$A = \|a_{ij}\|$$

$$a_{ij} = X_{ij}/X_{\cdot j}\,,$$

it being recognized that $X_{\cdot j}$ and $X_{j\cdot}$ are identical for every sector. X in the basic equation is a whole vector of total output elements across sectors. The column F is the total of final transactions in Figure 1. To show the tie to a macromodel of the economy as a whole, let us split F into two parts, a matrix of ratio coefficients and components of the GNP. We write this as

$$F = CG,$$

where the typical element of C can be expressed as

$$C = \|c_{ij}/c_{\cdot j}\|\,.$$

Delivery of the ith type of output to the jth type of final transaction is denoted by c_{ij}, and $c_{\cdot j}$ is the total expenditure on the jth type of final transaction. Each $c_{\cdot j}$ is a major component of GNP, denoted as G.

The typical macromodel is designed to provide estimators of GNP and its components; therefore, one might think of a one-way linkage process by which macromodel estimates of G can be transformed into estimates of X by the relation[2]

$$X = (I-A)^{-1}\,CG.$$

One-way linkage in complete model solutions is not generally possible, though, because equations for some components of G will depend on specific components of X, particularly the investment equations, which are usually some generalization of the accelerator principle. Sector price equations in a macromodel will depend on sector productivity, and this requires the estimation of output and employment by sector in order to solve the macromodel. It is because of these and other

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*This paper is based on "Trade Impact Studies Using the Wharton Annual and Industry Forecasting Model" by Ross S. Preston and Yuen-Yun C. O'Brien which was completed under ILAB contract 74-12 in 1976 at The Wharton Econometric Forecasting Associates.

[1] For a description of earlier generations of this Wharton model, see [2, 3].

[2] The ratio coefficients in C are not assumed to be constant. They are estimated, implicitly, by an adjustment process that is analogous to that used for the elements of A.

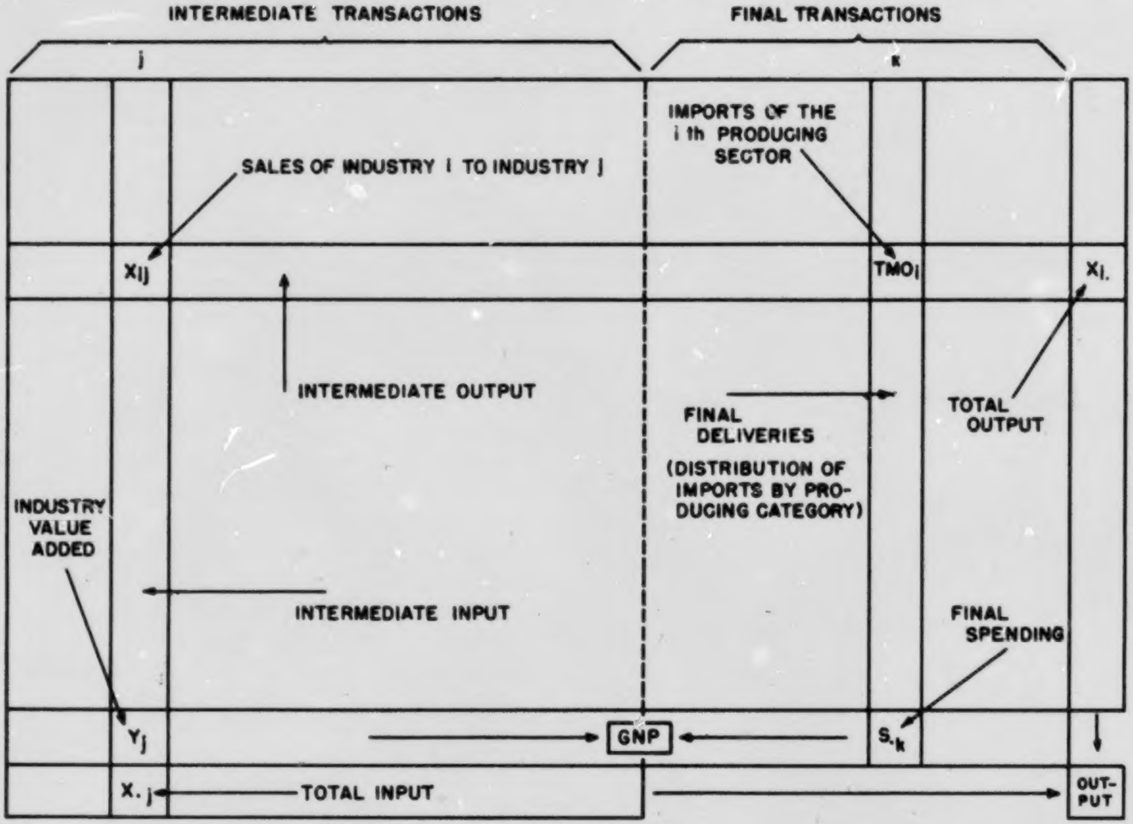
INTERMEDIATE TRANSACTIONS
FINAL TRANSACTIONS
j
k
SALES OF INDUSTRY i TO INDUSTRY j
IMPORTS OF THE i th PRODUCING SECTOR
X_{ij}
TMO_i
$X_{i.}$
INTERMEDIATE OUTPUT
FINAL DELIVERIES
(DISTRIBUTION OF IMPORTS BY PRODUCING CATEGORY)
TOTAL OUTPUT
INDUSTRY VALUE ADDED
INTERMEDIATE INPUT
FINAL SPENDING
Y_j
GNP
$S_{.k}$
$X_{.j}$
TOTAL INPUT
OUTPUT

Figure 1
The Input/Output Tableau

structural characteristics that the input-output system cannot be solved without simultaneously solving the macromodel and the macromodel cannot be solved without solving the input-output system. This feedback arrangement has always been a feature of the Wharton Annual and Industry Model.

The other main part of macromodel construction concerns the development of the components of national income. Their total when adjusted by well-known reconciling items (indirect taxes, subsidies, capital consumption) equals GNP in a basic accounting identity for almost any macromodel. The components of national income are modeled through production functions for value added output, giving employment required, capital accumulation functions, wage rate equations, interest rate equations, and so on. Factor prices multiplied into factor requirements gives factor income. These totals, together with some equations for miscellaneous factor payment flows (rents, royalties, self-employed incomes, and so forth) give total value added, and these are estimated by sectors. Because of data limitations, the sectors used for estimating value added are fewer in number than those treated separately in the input-output system. Some sectors are aggregated for estimation of national income.

The treatment of imports and exports within this system is central to the analysis of this study. On the side of final demand aggregates in the NIPA totals, there are six equations for imports of goods and services, covering the following categories: crude foods, manufactured foods, nonfood crude materials, semimanufactured materials, manufactured materials, and services. The all-important category of oil/gas imports is the dominant part for nonfood materials. There is, in addition, a single, overall equation for exports of goods and services. Exports depend mainly on external variables, namely world trade and world prices, but they also depend on domestic (export) prices.

The import column of the final demand part of the accounting layout gives the total for the entry for goods and services in the GNP. This total is then disaggregated into the six categories listed above, but there is another important way of looking at imports, namely, by producing sectors. These are the cell entries in the final demand column for imports.

A special disaggregation of these for the purposes of this study is listed in Table 1. This disaggregation is used in order to trace the impact of changes in imports on domestic producing sectors of the economy. The import equations developed for this study are all of a special form.

$$\ln \frac{TM}{DP} = a + \Sigma w_i \ln\left(\frac{PM_{-i}}{PGPO_{-i}}\right) + \Sigma q_i \ln (S_{-i}) + \Sigma r_i \ln SM_{-i},$$

where

TM = real imports
DP = domestic production
PM = import price index (unit values by six aggregate import categories)
$PGPO$ = price index of gross output originating by output sector
S = shipments
SM = stocks.

All the lag distributions are of finite length. The coefficients of relative price may be regarded as estimates of "elasticities of substitution." As the occasion requires, special dummy variables are introduced for quotas, strikes, embargoes, and so on, in particular markets.

The variables in all these import equations are sector specific. A summary listing of principal coefficients is given in Tables 2 – 4, followed by a definition of variables used in these equations in Tables 5 and 6.

An understanding of the treatment of the input-output sector of this Wharton model is also important for appreciating the way in which the import impact analysis is carried out. Intermediate inputs for a given sector measured as the cell entries in a column of the usual input-output accounting table are not estimated in fixed proportions. The ratio of any two intermediate inputs within a column are assumed to be proportional to a power of relative prices of those two inputs — the power being the elasticity of substitution within the sector. The technique for moving the estimated input-output coefficients through time as a function of relative price movements is a mathematical analog of the technique used to move coefficients of the international trade matrix through time, developed originally in research for Project LINK.[3]

Table 1

Disaggregation Level for Import Functions

Industry	Variable Name
Farm	TMO2
Agricultural services, forestry and fisheries	TMO3
Metal mining	TMO5
Crude petroleum and natural gas	TMO7
Mining and quarrying of nonmetallic minerals	TMO8
Contract construction	TMO9
Food and kindred products	TMO12
Tobacco manufactures	TMO13
Textile mill products	TMO14
Apparel and related products	TMO15
Paper and allied products	TMO16
Printing and publishing	TMO17
Chemicals and allied products	TMO18
Petroleum and related industries	TMO19
Rubber and miscellaneous products	TMO20
Leather and leather products	TMO21
Lumber and wood products, excluding furniture	TMO23
Furniture and fixtures	TMO24
Stone, clay and glass products	TMO25
Primary iron and steel	TMO27
Primary nonferrous metals	TMO28
Fabricated metal products	TMO29
Machinery, except electrical	TMO30
Electrical machinery	TMO31
Nonauto transportation equipment including ordnance	TMO32
Motor vehicles and equipment	TMO33
Instruments	TMO34
Miscellaneous manufacturing industries	TMO35
Railroad transportation	TMO37
Local and highway passenger transportation	TMO38
Motor freight and warehouse transportation	TMO39
Water transportation	TMO40
Air transportation	TMO41
Telephone and telegraph	TMO45
Utilities	TMO47
Services, except transportation, communications utilities	TMOS

This feature of the Wharton model, namely, that input-output coefficients be variable through time and estimated on the basis of relative price movements, is implemented through the following equations

$$\frac{X_{ij}}{X_{kj}} = \left(\frac{\delta_i}{\delta_k}\right)^{\sigma_j} \left(\frac{P_i}{P_k}\right)^{-\sigma_j}$$

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[3] [1]. The use of the Hickman-Lau method for input-output analysis is described in [3], but has been modified for explicit adjustment of the strict input-output coefficient matrix in the present study.

Table 2

Relative Price Response

Industry	Price Concept	Lag (negative sign on coefficients has been omitted) 0	1	2	3	4	5	6	Sum
Farm		—							
Agricultural services forestry and fisheries	ln(PMCF58/PGPO3)	0.5628							0.5628
Metal mining	ln (PMCM58/PGPO4)		0.0598	0.7114	1.4931	1.9429	1.5992		5.8065
Mining and quarrying of nonmetallic minerals	Δ ln (PMCM58/PGPO4)	0.7043	1.1824	1.4292	1.4395	1.2082	0.7301		6.6937
Contract construction		—							
Food and kindred products	Δ ln (PMMF58/PGPO12)	0.4690	0.6139	0.5369	0.3407	0.1216			2.0881
Tobacco manufactures	ln (PMFM58/PGPO13)			0.7541	1.2010	1.2708	0.8938		4.1196
Textile mill products	Δ ln(PMSM58/PGPO14)	0.5138	0.7660	0.8108	0.7024	0.4950	0.2428		3.5306
Apparel and related products	ln (PMFM58/PGPO15)		0.1272	0.2279	0.2925	0.3115	0.2754	.1748	1.4093
Paper and allied products	Δ ln (PMSM58/PGPO16)	0.7322	0.7278	0.3596					1.8196
Printing and publishing		—							
Chemicals and allied products	Δ ln (PMSM58/PGPO18)	0.2777	0.3294						0.6071
Petroleum and related industries	Δ ln (PMSM58/PGPO19)	0.3460	0.8882	1.2574	1.0844				3.5760
Rubber and miscellaneous plastic products	ln (PMSM58/PGPO20)	0.6315							0.6315
Leather and leather products		—							
Lumber and wood products	ln (PMSM58/PGPO23)	0.6240	0.5538	0.2067					1.3845
Furniture and fixtures	ln (PMFM58/PGPO24)	0.9101							0.9101
Stone, clay and glass		—							
Primary iron and steel	ln (PMSM58/PGPO26)	1.3456	1.2830	0.5788					3.2075
Primary nonferrous metals	ln (PMSM58/PGPO26)	1.2703							1.2703
Fabricated metal products	ln (PMSM58/PGPO29)	0.1697							0.1697
Machinery except electrical	ln (PMFM58/PGPO30)	0.9579							0.9579
Electrical machinery	ln (PMFM58/PGPO31)	0.7294							0.7294
Nonauto transportation equipment		—							
Motor vehicles and equipment	Δ ln (PMFM58/PGPO38)	1.2851							1.2851
Instruments		—							
Miscellaneous manufacturing	ln (PMFM58/PGPO3235)	0.9571							0.9571
Rail transportation	ln (PMSIO/PGPO36)	0.4192	0.5653	0.5018	0.2922				1.7785
Local and highway passenger transportation		—							
Motor freight and warehousing transportation	ln (PMSIO/PGPO36)	0.6825							0.6825
Water transportation	ln (PMSIO/PGPO36)	3.7401							3.7401
Air transportation		—							
Telephone and telegraph	ln (PMSIO/PGPO44)	0.8590							0.8590
Utilities		—							
Other services		—							

Table 3
Output Response

Industry	Lag 0	1	2	3	4	5	6	Sum
Farm	2.0485	1.5401						3.5885
Agricultural services, forestry and fisheries	3.2998	0.2115						3.5114
Metal mining		0.0424	0.2651	0.4666	0.4454			1.2196
Mining and quarrying of nonmetallic minerals		0.1902	0.3697	0.4894	0.5003	0.3535		1.9031
Contract construction		0.6329	1.1888	1.1503				2.9721
Food and kindred products	1.9279							1.9279
Tobacco manufactures	1.3988							1.3988
Textile mill products	0.5106	0.5778	0.3897	0.1344				1.6124
Apparel and related products		0.0912	0.4863	0.8358	0.7903			2.2036
Paper and allied products	1.0633	1.0393	0.4956					2.5982
Printing and publishing		0.1021	0.4434	0.7337	0.6827			1.9620
Chemical and allied products	0.5013	1.0263						1.5277
Petroleum and related products	—							
Rubber and miscellaneous plastic products		0.0109	0.1278	0.2678	0.3484	0.2867		1.0416
Leather and leather products		0.1273	0.3211	0.5161	0.6468	0.6480	0.4541	2.7135
Lumber and wood products		0.2795	0.7236	0.8059				1.8090
Furniture and fixtures		0.3714	0.4466	0.3360	0.1503			1.3042
Stone, clay and glass products		0.6855	1.0554	1.1620	1.0574	0.7941	0.4242	5.1786
Primary iron and steel		0.4934	0.6937	0.6781	0.5237	0.3078	0.1075	2.8042
Primary, nonferrous metals		0.2155	1.0359					1.2514
Fabricated metal products	0.7102	0.2313						0.9415
Nonelectrical machinery	0.3376	0.4121						0.7497
Electrical machinery	0.4810	0.5004	0.2697					1.2511
Nonauto transportation equipment and ordnance	1.3216							1.3216
Motor vehicles and equipment		0.6990						0.6990
Instrument and related products		0.3835						0.3835
Miscellaneous manufacturing	0.4883	0.4093	0.1257					1.0233
Railroad transportation		0.0314	0.1376	0.2675	0.3699	0.3935	0.2873	1.4871
Local and highway passenger transportation		0.7562						0.7562
Motor freight and warehousing transportation	0.2917	0.7314	1.0252	0.8794				2.9277
Water transportation		0.2991	0.3020	0.1553	0.0058			0.7621
Air transportation	—							
Telephone and telegraph	0.1807	0.4085	0.5938	0.6472	0.4791			2.3094
Utilities	0.5641							0.5641
Total services except transportation, communication and utilities	0.1687	0.4004	0.6237	0.7668	0.7583	0.5265		3.2445

These are cost minimizing conditions for a CES production process

$$X_{.j} - Y_j = \left[\sum_{i=1}^{n} \delta_i \, X_{ij}{}^{\sigma_j - 1/\sigma_j} \right]^{\sigma_j/\sigma_j - 1} ,$$

Y_j = value added in sector j.

Linear approximations to the cost-minimizing conditions are estimated for each sector. Other approaches to input-output systems with variable coefficients have been carried out for Cobb-Douglas and translog systems. The former appear to be too restrictive and the latter to be very general (with many unknown parameters); the CES case appears to work well in construction and applications with the Wharton model. It is well adapted to the study of substitution effects in international trade because relative price changes and differentials are the central issue in this analysis.

The intermediate inputs in the technological process

Table 4

Inventory Stock Response

Industry	Lag 0	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Sum
Farm	—							
Agricultural services, forestry and fisheries	−0.2204							−0.2204
Metal mining	—							
Mining and quarrying of nonmetallic minerals	—							
Contract construction	—							
Food and kindred products	−0.0530	−0.1022	−0.1003					−0.2555
Tobacco manufactures	−0.3866	−0.4413	−0.2754					−1.1033
Textile mill products	—							
Apparel and related products	—							
Paper and allied products	−0.7322	−0.7278	−0.3596					−1.8196
Printing and publishing		−0.0061	−0.0899	−0.1913	−0.2502	−0.2065		−0.7440
Chemical and allied products	−0.2680	−0.2118						−0.4797
Petroleum and related products	−0.9840	−0.8501	−0.2911					−2.1252
Rubber and miscellaneous plastic products	—							
Leather and leather products	−0.2601	−0.2052	−0.0476					−0.5129
Lumber and wood products	—							
Furniture and fixtures	−0.3347	−0.4966	−0.5225	−0.4491	−0.3131	−0.1511		−2.2672
Stone, clay and glass products	−0.0725	−0.1433	−0.1990	−0.2259	−0.2108	−0.1400		−0.9914
Primary iron and steel	−0.0117	−0.2311	−0.5312	−0.7850	−0.8657	−0.6463		−3.0710
Primary, nonferrous metal	−0.7528	−1.0418	−0.9947	−0.7392	−0.4031	−0.1141		−4.0459
Fabricated metal products	−0.1907	−0.2949	−0.3265	−0.2990	−0.2263	−0.1221		−1.4595
Nonelectrical machinery	−0.4077	−0.6562	−0.7595	−0.7315	−0.5863	−0.3378		−3.4789
Electrical machinery	—							
Nonauto transportation equipment and ordnance	−0.7394	−0.9530	−0.7968	−0.4271				−2.9163
Motor vehicles and equipment		−0.3036	−0.4207	−0.4024	−0.3000	−0.1647	−0.0476	−1.6389
Instrument and related products	0.3379	0.4764	0.4635	0.3477	0.1771			1.8026
Miscellaneous manufacturing	—							

are thus modeled according to a CES production function specification. Value added can be obtained from gross output by subtracting intermediate input, and for this part of the production process, this Wharton model uses a Cobb-Douglas specification, with appropriate allowance for technical progress and short-run dynamic adaptation.

The production function for gross output, therefore, consists of two additive parts — one covering intermediate inputs and one covering factor inputs. The total equation is

$$X_{.j} = \left[\sum_{i=1}^{n} \delta_i \, x_{ij}^{\sigma_j^{-1}/\sigma_j} \right]^{\sigma_j/\sigma_j^{-1}} + A_j L_j^{\alpha_j} K_j^{\beta_j} e^{\gamma_j t}.$$

Productions is, in general, assumed to be carried out according to a VES process, which is the sum of a CES and Cobb-Douglas function. These are purely simplifying empirical assumptions, that are very convenient to estimate and apply.

The model has been put through the usual validation tests. It has been simulated in *one-period* solutions from 1960 through 1971. Sample data for intial conditions (lags) and exogenous variables are used for these simulations. Error statistics for complete model performance, measured as mean absolute percentage error (MAPE) are given in separate tables by model composition. Table 7 gives MAPE statistics for major aggregates. These are all under 3 percent and often under 1 or 2 percent. The corresponding statistics for imports by industrial sector are given in Table 8. These highly disaggregated import flows are not as closely estimated as the main aggregates. Although total imports are estimated with an error of about 2 percent, most of the sector imports have MAPE statistics between 2 and 4 percent. Some are between 5 and 8 percent.

Error statistics for sector output and labor requirements are given in Tables 9 and 10. Most of the individual output errors are under 4 percent or even 3 percent, and the employment/man hours statistics are equally small. Generally speaking, the separate error statistics for imports are a bit larger, but this study is trying to break new ground in the detailed treatment of imports, and it is not surprising, therefore, that the initial attempt contains more error than is likely to be the case with repeated application of the methods set out here.

The central aim of the study is to analyze the impact of changes in imports on the economy as a whole, and on output/employment variables by sector. To do this, once the model has been constructed, we have to establish a baseline or control simulation for a period of investigation (1975–80) and comparative simulations in which specified changes are introduced in the trade sectors.

The control solution is initialized from December 1974, and extrapolated for the solution period 1975–80. The economy was in recession at the initialization period. The control solution projected a slow recovery of the economy, reaching an unemployment rate of 5 percent by 1980. The main assumptions for the control solution concerned input values for government pur-

Table 5

Glossary

Industry	Imports	Domestic Production	Shipment Excluding Own Consumption	Output Originating	Sector Price
Agriculture, forestry and fisheries	TMO1				
Farm	TMO2	DP2	S2	GPO2	
Agricultural services, forestry and fisheries	TMO3	DP3	S3	GPO3	PGPO3
Mining	TMO4				PGPO4
Metal mining	TMO5	DP5	S5	GPO5	
Coal mining	TMO6	DP6	S6	GPO6	
Crude petroleum and natural gas	TMO7	DP7	S7	GPO7	
Mining and quarrying of nonmetallic minerals	TMO8	DP8	S8	GPO8	
Contract construction	TMO9	DP9	S9	GPO9	
Nondurable manufacturing	TMO11				
Food and kindred products	TMO12	DP12	S12	GPO12	PGPO12
Tobacco manufactures	TMO13	DP13	S13	GPO13	PGPO13
Textile mill products	TMO14	DP14	S14	GPO14	PGPO14
Apparel and related products	TMO15	DP15	S15	GPO15	PGPO15
Paper and allied products	TMO16	DP16	S16	GPO16	PGPO16
Printing and publishing	TMO17	DP17	S17	GPO17	
Chemical and allied products	TMO18	DP18	S18	GPO18	PGPO18
Petroleum and related industries	TMO19	DP19	S19	GPO19	PGPO19
Rubber and miscellaneous plastic products	TMO20	DP20	S20	GPO20	PGPO20
Leather and leather products	TMO21	DP21	S21	GPO21	
Durable maufacturing	TMO22				
Lumber and wood products, except furniture	TMO23	DP23	S23	GPO23	PGPO23
Furniture and fixtures	TMO24	DP24	S24	GPO24	PGPO24
Stone, clay and glass products	TMO25	DP25	S25	GPO25	
Primary metals					PGPO26
Primary iron and steel	TMO27	DP27	S27	GPO27	
Primary nonferrous metals	TMO28	DP28	S28	GPO28	
Fabricated metal products	TMO29	DP29	S29	GPO29	PGPO29
Nonelectrical machinery	TMO30	DP30	S30	GPO30	PGPO30
Electrical machinery	TMO31	DP31	S31	GPO31	PGPO31
Nonauto transportation equipment and ordnance	TMO32	DP32	S32	GPO32	
Motor vehicles and equipment	TMO33	DP33	S33	GPO33	PGPO33
Instruments and related products	TMO34	DP34	S34	GPO34	
Miscellaneous durable manufacturing	TMO35	DP35	S35	GPO35	
Nonauto transportation equipment and ordnance plus miscellaneous durable manufacturing					PGPO3235

Table 5 (continued)

Industry	Imports	Domestic Production	Shipment Excluding Own Consumption	Output Originating	Sector Price
Total transportation services	TMO36				PGPO36
Rail transportation services	TMO37	DP37	S37	GPO37	
Local and highway passenger transportation services	TMO38	DP38	S38	GPO38	
Motor freight and warehousing transportation services	TMO39	DP39	S39	GPO39	
Water transportation services	TMO40	DP40	S40	GPO40	
Air transportation services	TMO41	DP41	S41	GPO41	
Pipeline transportation services	TMO42	DP42	S42	GPO42	
Other transportation services	TMO43	DP43	S43	GPO43	
Total Communication	TMO44				PGPO44
Telephone and telegraph	TMO45	DP45	S45	GPO45	
Radio and television	TMO46	DP46	S46	GPO46	
Electric, gas and sanitary services	TMO47	DP47	S47	GPO47	
Total services, except transportation, Communications and utilities	TMOS	DPS	SS		
Wholesale trade	TMO49	DP49	S49	GPO49	
Retail trade	TMO50	DP50	S50	GPO50	
Banking	TMO52	DP52	S52	GPO52	
Credit agencies, holding and investment company	TMO53	DP53	S53	GPO53	
Security and commodity brokers	TMO54	DP54	S54	GPO54	
Insurance carriers	TMO55	DP55	S55	GPO55	
Insurance agents, brokers and services	TMO56	DP56	S56	GPO56	
Real estate and combination offices	TMO57	DP57	S57	GPO57	
Hotels and lodging places	TMO59	DP59	S59	GPO59	
Personal and miscellaneous repair services	TMO80	DP80	S80	GPO80	
Miscellaneous business services	TMO61	DP61	S61	GPO61	
Auto repair, auto services and garages	TMO62	DP62	S62	GPO62	
Motion pictures	TMO64	DP64	S64	GPO64	
Amusement and recreation, except motion pictures	TMO65	DP65	S65	GPO65	
Medical and other health services	TMO66	DP66	S66	GPO66	
Legal and miscellaneous professional services	TMO81	DP81	S81	GPO81	
Educational services	TMO68	DP68	S68	GPO68	
Nonprofit membership organizations	TMO69	DP69	S69	GPO69	
Government industry	TMO82	DP82	S82	GPO82	
Government, federal enterprises	TMO75	DP75	S75	GPO75	
Government, state and local enterprises	TMO78	DP78	S78	GPO78	
Rest of the world	TMO79	DP79	S79	GPO79	
Private households	TMO71	DP71	S71	GPO71	

chases, some particular prices, government employment, monetary policy, fiscal policy, and world trade.

Modest increments in real nondefense spending and very small increments in real defense spending were assumed. Higher than average inflation accounted for more substantial current dollar increments in both types of spending. State and local spending was projected to rise more rapidly in real terms and also assumed relatively high price rises. Agricultural prices were made to move up sharply during 1975–76, to decline in 1977, and to rise by about 5 percent annually after that point. Defense manpower was leveled off at two million. Small growth was projected for federal civilian jobs and one million were added for state and local jobs over the whole simulation period.

Credit policy was assumed to be easy in 1976 and by another step in 1977. It was not changed markedly after that date. Import prices were variously set on growth paths of 4 to 6 percent and world trade volume at 5 to 6 percent, followed by 7.5 percent after 1977. Statutory changes in social security payments were introduced, but tax cuts during 1975–76 were not assumed (con-

Table 6
Other Variables

CMIBQ	Dummy, percentage change in meat import adjusted base quota for those years that the quota was in effect
DCUBA	Dummy, 1.0 for years Cuba stopped exporting cigars to the United States
DCUSTK	Dummy, for strikes in the domestic copper industry
DD	Dummy, 1.0 for 1965–67; 0 elsewhere for U.S. government disposals of copper
DX	Dummy, 1.0 for 1959–64; 0 elsewhere for special conditions in domestic primary refined copper production
IM	Imports, total goods and services
PMCF58	Unit value index for the imports of crude foods, 1958 = 100.0
PMMF58	Unit value index for the imports of manufactured foods, 1958 = 100.0
PMCM58	Unit value index for the imports of nonfood crude materials, 1958 = 100.0
PMSM58	Unit value index for the imports of semimanufactures, 1958 = 100.0
PMFM58	Unit value index for the imports of finished manufactures, 1958 = 100.0
PMSIO	Unit value index for the imports of services, derived from input/output table to preserve the NIA current dollar identity, 1958 = 100.0
SFAI	Farm inventory stock
SMI	Manufactures inventory stock
TIME	Trend, 52.0 for 1952
TMO7RD	Percentage ratio of imports to domestic production for crude petroleum and natural gas
TMORi	Percentage ratio of imports of producing sector i to TMOS.

trary to what actually happened). A tax cut of $10 billion was programmed for 1977. The investment tax credit rate was set at 8 percent during 1975–76.

The resulting control solution shows a steady return to full employment along a path that is less pessimistic than the OMB outlook presented in the *Budget of the United States Government, 1976* (p. 41). As the economy approaches full employment in this solution, the federal deficit falls and the inflation rate comes down. A summary tabulation of the main aggregates in the control solution is given in Table 11.

In terms of today's economy and what is being planned for it in contemporary policy, this appears to have been a perceptive extrapolation. It serves as a realistic baseline case against which to judge various trade alternatives. It must be remembered, however, that Table 11 is presented in 1958 prices. These formed the base system of U.S. accounts prior to January 1976, and were the data available at the time the present study was made. The version of the Wharton model used here has since been retired and replaced by one that is estimated from the new, revised data.

The first alternative simulation is for an across-the-board increase in import prices by 10 percent above the

Table 7
Mean Absolute Percentage Error (MAPE)

Major Aggregates

Indicator		(MAPE)
Gross national product		
(current $)	GNP*	.96
(58 $)	GNP	.76
Personal consumption expenditure (current $)	PCE*	.88
(58 $)	PCE	.74
Fixed investment (current $)	FI*	2.07
	FI	2.15
Nonresidential investment	NRI	2.29
Imports (current $)	IM*	2.07
(58 $)	IM	2.05
Output		
Agriculture, forestry and fisheries	GPO1	2.35
Agricultural services, forestry and fisheries	GPO3	1.10
Mining	GPO4	2.32
Contract construction	GPO9	2.98
Durable manufacturing	GPO22	2.86
Nondurable manufacturing	GPO11	1.31
Transportation services	GPO36	1.67
Communications	GPO44	1.88
Utilities	GPO47	1.95
Commercial and others	GPORES	.65
Money supply	MSPL	1.21
Personal income	PI	.96
Disposal personal income	DPI	.90
Employee compensation, all industries	EMCOT	1.23
Wage rate, total	WT	.87
Deflator		
Gross national product	GNPD	.34
Personal consumption expenditure	PCED	.32
Fixed investment	FID	.78
Sector price		
Manufacturing	PGPO10	.39
Durable manufacturing	PGPO22	.61
Nondurable manufacturing	PGPO11	.21

Table 8
Mean Absolute Percentage Error (MAPE)

Industry	Imports	(MAPE)
Agriculture, forestry and fisheries	TMO1	5.45
Farm	TMO2	4.32
Agricultural services, forestry and fisheries	TMO3	8.70
Mining	TMO4	2.68
Metal mining	TMO5	4.81
Crude petroleum and natural gas	TMO7	2.18
Mining and quarrying of nonmetallic minerals	TMO8	4.08
Contract construction	TMO9	6.22
Manufacturing	TMO10	2.27
Nondurable manufacturing	TMO11	3.38
Food and kindred products	TMO12	5.76
Tobacco manufactures	TMO13	8.42
Textile mill products	TMO14	3.62
Apparel and related products	TMO15	1.46
Paper and allied products	TMO16	2.27
Printing and publishing	TMO17	2.58
Chemical and allied products	TMO18	2.89
Petroleum and related industries	TMO19	3.56
Rubber and miscellaneous plastic products	TMO20	3.06
Leather and leather products	TMO21	3.42
Durable manufacturing	TMO22	1.76
Lumber and wood products, except furniture	TMO23	2.45
Furniture and fixtures	TMO24	3.80
Stone, clay and glass products	TMO25	2.71
Primary iron and steel	TMO27	3.76
Primary nonferrous metals	TMO28	3.48
Fabricated metal products	TMO29	2.61
Nonelectrical machinery	TMO30	3.15
Electrical machinery	TMO31	2.42
Nonauto transportation equipment and ordnance	TMO32	3.77
Motor vehicles and equipment	TMO33	3.71
Instruments and related products	TMO34	1.94
Miscellaneous durable manufacturing	TMO35	2.70
Total transportation services	TMO36	3.39
Rail transportation services	TMO37	3.12
Local and highway passenger transportation services	TMO38	4.14
Motor freight and warehousing transportation services	TMO39	2.29
Water transportation services	TMO40	4.52
Air transportation services	TMO41	3.05
Total communications	TMO44	2.61
Telephone and telegraph	TMO45	2.61
Electric, gas and sanitary services	TMO47	3.50
Total services, except transportation, communications and utilities	TMOS	2.06

control solution path. The initial impact of the higher import prices is a reduction of imports, by nearly $2.0 billion. This decline gradually gets larger and reaches a figure of $3.35 billion by 1980, according to the multiplier simulation. The major impact occurs within the manufacturing sector. Of the initial impact, $1.81 billion is traceable directly to manufacturing imports, split fairly evenly between durable and nondurable lines. But the gradual decline in manufacturing imports is much less than for imports as a whole. By 1980, the cutback in manufacturing imports is only $2.28 billion compared with estimates of $3.35 billion for total imports. The impact declines over time in nondurable manufacturing, but increases in durables.

As for the inflationary consequences of increasing import prices, it would appear that there is an initial decline in the GNP deflator. This is because imports enter the GNP calculation explicitly with a negative sign (in computing *net* exports). After four years, however, the inflationary forces show through, even in the GNP deflator, and the overall price index is greater in the changed solution than in the control solution. The deflator of consumer expenditures is less ambiguous; it shows an inflationary impact effect of 0.53 index points at the beginning and gradually rises to an impact effect of 4.58 index points.

The higher import prices, followed by reduced imports, tends to create additional domestic jobs. In the first year, there are an estimated 38,000 new jobs created, 29,000 of those in manufacturing. After a few years, however, the price increases brought about by the higher import costs lower aggregate activity and

Table 9

Mean Absolute Percentage Error (MAPE)

Industry		Output (MAPE)
Farm	S2	1.40
Agricultural services, forestry and fisheries	S3	2.21
Metal mining	S5	3.56
Mining and quarrying of nonmetallic minerals	S8	2.23
Contract construction	S9	2.69
Nondurable manufacturing		
Food and kindred products	S12	1.61
Tobacco manufactures	S13	2.40
Textile mill products	S14	1.77
Apparel and related products	S15	1.67
Paper and allied products	S16	1.68
Printing and publishing	S17	1.92
Chemical and allied products	S18	1.99
Petroleum and related industries	S19	1.69
Rubber and miscellaneous plastic products	S20	3.06
Leather and leather products	S21	3.96
Durable manufacturing		
Lumber and wood products, except furniture	S23	1.12
Furniture and fixtures	S24	5.39
Stone, clay and glass products	S25	1.88
Primary iron and steel	S27	3.84
Primary nonferrous metals	S28	2.33
Fabricated metal products	S29	3.63
Nonelectrical machinery	S30	3.32
Electrical machinery	S31	2.85
Nonauto transportation equipment and ordnance	S32	2.18
Motor vehicles and equipment	S33	5.99
Instruments and related products	S34	3.66
Miscellaneous durable manufacturing	S35	1.94
Total transportation services		
Rail transportation services	S37	2.29
Local and highway passenger transportation services	S38	3.04
Motor freight and warehousing transportation services	S39	1.47
Water transportation services	S40	1.99
Air transportation services	S41	5.13
Telephone and telegraph	S45	1.75
Electric, gas and sanitary services	S47	1.90
Total services, except transportation, communications and utilities	SS	.59
Wholesale trade	S49	1.32
Retail trade	S50	1.40
Banking	S52	3.57
Credit agencies, holding and investment company	S53	91.67
Security and commodity brokers	S54	6.85
Insurance carriers	S55	2.36
Insurance agents, brokers and services	S56	2.10
Real estate and combination offices	S57	1.19
Hotels and lodging places	S59	3.17
Personal and miscellaneous repair services	S80	1.70
Miscellaneous business services	S61	1.10
Auto repair, auto services and garages	S62	1.92
Motion pictures	S64	2.51
Amusement and recreation, except motion pictures	S65	2.03
Medical and other health services	S66	1.75
Legal and miscellaneous repair services	S81	1.89
Educational services	S68	1.41
Nonprofit membership organizations	S69	1.03
Government industry	S82	1.73
Government, federal enterprises	S75	6.71
Government, state and local enterprises	S78	1.59
Rest of world	S79	6.70
Private households	S71	8.98

consequently, job opportunities. The moral is, thus, quite clear. Short-run gains are not sustainable. The higher import prices lead to more inflation which, in turn, depresses spending together with overall activity and ultimately results in fewer job opportunities.

The second set of alternative simulations increases imports in each of thirty-six import demand categories by $1 billion. These are one-at-a-time changes; i.e. one category of imports is increased while others are unchanged. There is a regular pattern to most of these industry-import simulations, namely that the industry whose imports are being increased has the major and most easily discernible decrease in employment. It also happens in most cases that the model tends to have a major part of the adjustment taken up by movements (in the same direction as in the industry directly affected) in

Table 10
Mean Absolute Percentage Error (MAPE)

	Employment and Manhours			
	Employment		Manhours	
		(MAPE)		(MAPE)
All industries	NT	0.50		
Farm	N1	1.71		
Mining	N2	2.93	MH2	3.69
Manufacturing	N33	1.32	MH33	1.67
Nondurable manufacturing	N34	0.97	MH34	1.37
Food and kindred products	N19	0.48	MH19	0.63
Tobacco manufactures	N25	2.14	MH25	2.28
Textile mill products	N20	1.65	MH20	2.06
Apparel and related products	N26	1.55	MH26	2.01
Paper and allied products	N21	1.66	MH21	1.95
Printing and publishing	N28	1.15	MH28	1.40
Chemical and allied products	N22	2.59	MH22	2.54
Petroleum and related industries	N23	2.17	MH23	1.94
Rubber and miscellaneous plastic products	N24	3.17	MH24	3.96
Leather and leather products	N27	2.15	MH27	2.62
Durable manufacturing	N35	1.84	MH35	2.19
Lumber and wood products, except furniture	N14	1.28	MH14	1.33
Furniture and fixtures	N15	3.54	MH15	3.92
Stone, clay and glass products	N12	1.42	MH12	1.56
Primary metals	N3	2.49	MH3	3.11
Fabricated metal products	N13	2.39	MH13	2.97
Nonelectrical machinery	N7	2.32	MH7	3.11
Electrical machinery	N6	3.17	MH6	3.30
Motor vehicles and equipment	N9	5.12	MH9	5.56
Instruments and related products	N16	2.02	MH16	2.29
Nonauto transportation equipment and ordnance plus miscellaneous durable manufacturing	N44	2.29	MH44	2.46
Total regulated sectors	N29	1.02		
Total transportation services	N39	0.87		
Total communications	N31	2.62		
Electric, gas and sanitary services	N30	0.58		
Commercial and other	N32	0.41		

the commercial sector. This may or may not be a plausible result.

Some examples show the relative magnitudes of effects. If farm imports are increased by $1 billion, there would be, according to the model, about 30,000 fewer jobs in farming initially. In the economy as a whole, the job loss would be about 43,000. After seven years, we estimate that the farm loss would be 77,000 jobs, and total employment would fall by 109,000.

Consider the automobile industry. If motor vehicle imports are raised by $1 billion, the model estimates that 9,000 jobs would be lost in the automobile sector compared with 60,000 in the economy as a whole. The ratio of these two figures is somewhat more than six to one. After seven years, the estimate is that 17,000 jobs would be lost in the motor vehicle sector against 94,000 in the economy at large. The ratio falls to about five to one.

Industries that are closely tied to motor vehicle production also suffer parallel job losses. Primary metals and fabricated metals are two cases in point. Their combined job loss exceeds that of motor vehicles. This is indicative of part of the multiplier effect. Such an effect is indicative of the great economic importance of the motor vehicle industry for the United States.

In a third set of simulations, the ratio of crude oil

Table 11
Control Solution
New Wharton Annual and Industry Forecasting Model Dependence on Foreign Oil After 1975
February 1975

Selected Indicators	Model Label	Model Var	1973	1974	1975	Forecast Data 1976	1977	1978	1979	1980
Gross National Product (cur $)	GNP	618I	1294.9	1396.1	1483.7	1638.0	1866.0	2117.1	2331.4	2543.7
Percent change			11.8	7.8	6.3	10.4	13.9	13.5	10.1	9.1
Gross national product (58 $)	GNP	165I	839.2	821.3	798.0	820.6	890.1	963.3	999.9	1018.3
Percent change			5.9	−2.1	−2.8	2.8	8.5	8.2	3.8	1.8
Gross nat. prod. defl. (1958=100.0)	GNPD	647I	154.3	170.0	185.9	199.6	209.6	219.8	233.2	249.8
Percent change			5.6	10.2	9.4	7.4	5.0	4.8	6.1	7.1
Labor force (millions)	CLFT	288I	88.7	91.0	92.4	93.2	95.1	97.0	98.5	100.2
Percent change			2.5	2.6	1.5	0.8	2.0	2.0	1.5	1.7
Participation rate			59.9	60.4	60.2	59.7	60.0	60.3	60.3	60.4
Percent change			0.7	0.8	−0.2	−0.8	0.4	0.5	0.0	0.2
Manufacturing average weekly hours	H33	210I	40.8	40.3	40.0	40.3	40.7	40.8	40.7	40.6
Percent change			0.2	−1.0	−0.7	0.7	0.8	0.4	−0.4	−0.3
Productivity (manufacturing)			648.5	639.7	651.8	677.0	706.9	734.5	753.1	772.2
Percent change			5.8	−1.3	1.9	3.9	4.4	3.9	2.5	2.5
Money supply (demand+time deposits)	MSPL	692I	634.9	698.6	764.6	825.7	881.0	974.4	1096.4	1229.7
Percent change			11.6	10.0	9.4	8.0	6.7	10.6	12.5	12.2
Bond rate (%)	TR	323B	7.8	9.1	9.5	9.7	9.4	8.8	8.5	8.6
Prime commercial paper rate (%)	PCP	691B	8.1	9.9	6.4	7.3	6.8	6.7	7.1	7.3
Corporate profits (cur $)	PBT	737I	122.7	143.2	122.1	152.0	187.8	232.2	260.8	292.6
Percent change			23.7	16.7	−14.7	24.5	23.6	23.7	12.3	12.2
Manufacturing output (58 $)	GPO10	059I	272.4	263.2	254.3	266.1	293.9	319.8	329.8	336.1
Percent change			11.0	−3.4	−3.4	4.6	10.5	8.8	3.1	1.9
Nondurable goods (58 $)	GPO11	060I	112.7	110.6	108.9	111.8	120.3	129.7	133.0	134.3
Percent change			8.5	−1.9	−1.5	2.7	7.6	7.8	2.5	1.0
Durable goods (58 $)	GPO22	071I	159.7	152.6	145.4	154.2	173.6	190.0	[illegible]	201.8
Percent change			12.8	−4.4	−4.7	6.0	12.6	9.5	[illegible]	2.5
Unemployment rate (%)	UNR	286I	4.9	5.7	8.3	8.4	7.8	6.4	5.4	5.2
Savings rate (%)	SR	771I	8.2	7.4	9.5	8.9	7.8	7.3	6.5	6.3
Surplus or deficit, federal (cur $)	SDF	777I	−5.6	−6.2	−53.4	−56.2	−33.3	−15.6	−11.4	−10.7
Surplus or def., state & loc (cur $)	SDS	780I	9.2	1.9	−4.7	−3.2	1.9	6.4	6.5	3.0
Ratios										
Consumption to disposable income			89.1	90.0	88.0	88.7	89.5	90.1	90.9	91.0
Fixed investment to gross nat. prod.			15.0	14.0	13.0	13.6	14.7	15.5	15.5	15.9
Compen. to employees to nat. income			73.8	74.9	75.2	74.4	73.7	73.6	74.5	75.0
Profits to national income			11.5	12.6	10.1	11.4	12.3	13.4	13.6	14.0
Farm income to national income			3.6	2.8	2.6	2.5	2.2	2.0	1.9	1.8
Other income to national income			13.0	13.4	13.8	13.0	12.6	11.8	11.0	10.5

imports to domestic production is held constant. The initial impact is small, but by the sixth year, imports are reduced by $1.7 billion. Activity is stimulated in domestic oil/gas production and there are increases in real GNP by $2.76 billion above the control solution value. Imports are induced in other sectors, and, as a result, total imports decline by only $1.2 billion. This brings out an interesting point. Increased domestic activity associated with strict import-domestic production ratios has secondary effects that induce imports elsewhere, thus reducing any initial gains.

The import price increase across the board was introduced without any direct change in export conditions. If the change occurred as a result of dollar devaluation, there would be a quantity response on the side of exports. The long-run elasticity of imports was increased from 0.36 to 0.664 (by making services price sensitive) together with the introduction of an elasticity for exports at 0.5. Without the adjustment to exports, the increase in import prices now gives rise to 117,000 more jobs in manufacturing, but these are offset by losses in the service sector. Real GNP does not change. But if we include the 0.5 elasticity for exports, there is an overall increase of 507,000 jobs. The trade balance improves by $4.2 billion. Personal income and the federal budget balance improve. These are elasticity-optimist results in contrast with elasticity-pessimist results for the case in which export elasticity is set at zero.

Finally, there is a duty reduction scenario — a cut of 50 percent in tariffs. There is an immediate and sustained increase in net exports. Consumer prices are shaved, together with slight increases in GNP and employment. The net gain totals 75,000 jobs by 1980. If duty reduction and devaluation are combined, 581,000 jobs are created by 1980, with somewhat fewer than under the pure devaluation case in manufacturing but with many more in commercial employment. Duty reduction appears to have a relatively strong effect in the commercial sector and devaluation on manufacturing (especially in durables).

Literature Cited

1. Hickman, Bert G., and L. Lau. "Elasticities of Substitution and Export Demands in a World Trade Model." *European Economic Review*, 4 (1973), 347–80.
2. Preston, Ross S. *The Wharton Annual and Industry Forecasting Model*. Philadelphia: University of Pennsylvania, Economic Research Unit, 1972.
3. ______. "The Wharton Long-Term Model: Input/Output within the Context of a Macro Forecasting Model." *International Economic Review*, 16 (February 1975), 3–19.

Comment

Clopper Almon

Lawrence Klein's succinct paper is a summary of a 556-page volume by Ross Preston and Yuen-Yun O'Brien, *Trade Impact Studies Using the Wharton Annual and Industry Forecasting Model*. This treatise, to which all page numbers in this comment refer, provides a valuable overview of the Wharton annual model plus special chapters on the sixty-industry input-output block of the model, on the production functions, on the import equations, as well as on the simulations of the effects of changes in foreign trade. This work represents a very substantial achievement in the integration of input-output industrial detail into a macromodel. My comments, however, in keeping with the interests of this conference, will be limited to the parts dealing with international trade. Unfortunately, this part of the model appears to be its weakest link, and I find myself pointing out the weak points of a model which has many strong points which it would be more pleasant to emphasize. These weak points can be readily remedied, and I am sure they will be. The principal and most paradoxial result of the trade impact studies will then, I suspect, vanish.

That striking and paradoxical result comes from the simulation of an increase of all import prices by 10 percent. Relative prices for exports are unchanged. In effect, we are looking at the impact of a 10 percent across-the-board duty. One would expect such a measure to have a short-run stimulative effect on the economy, but after a few years the employment level should return to what it would have been without the stimulus, and real GNP should be smaller. The equilibrium level of employment should certainly not depend on the terms of trade, but the level of real GNP should.

In the model, the initial stimulus proves rather weak; only 38,000 jobs are created in the first year. In the second year, 6,000 of these are lost; in the third, another 50,000 are lost; in the fourth, another 99,000; in the fifth, 126,000; in the sixth, 95,000, in the seventh 132,000, for a total loss of 459,000 relative to the control solution. Real GNP is off 8.4 billion 1958 dollars. The economy has been put into an accelerating tailspin by this "stimulus." Contrary to expectations, changes in terms of trade seem to have long-run effects on the level of employment.

If this result is correct; if it describes what would happen in response to an across-the-board duty, then it is certainly a potent argument against protection. But is it correct? What causes the accelerating recession?

Preston sees the cause in inflation. He states: "In the initial year of impact, increasing import prices by ten percent has the effect of reducing prices by approximately one index number point. . . . This result is directly related to the fact that import prices enter the gross national product identity with a negative weight. If import prices are increased, . . . the increase has a tendency to reduce domestic price levels, other things being equal. The long run impact . . . , however, appears to be inflationary. The inflationary tendencies of increased import prices eventually depress the real demand categories of the disturbed solution below our control solution." (p. 405)

This is a revealing, though contestable passage. In the first place, import prices should enter the GNP deflator with a zero, not a negative weight. An increase in the price of an imported car increases personal consumption expenditures in current dollars and then this increase is *canceled out* of GNP by the increase in import prices. Similarly, an increase in the price of imported crude oil should increase the price of refined products and, gradually, of everything made with them. All these price rises increase the current dollar value of consumption and investment, but the increase is again *canceled out* of GNP by the increase in the current dollar value of imports. Apparently, only the second, the canceling-out part of this process is modeled at present. That is surely just a technical defect that can be remedied. But until it is fixed, the analysis of the inflationary effects of increasing import prices is misleading.

In the second place, I cannot agree that it is the "inflationary tendencies" which in the present model "eventually depress the real demand categories." The wage rate and the consumption deflator rise pari passu, (p. 416). Something else must be holding down demand. Also, if the stimulus of the duty set off the rise in prices,why does not the slack demand halt the inflation? What then does cause this recession? I have been unable to put my finger on the cause, but my search has turned up some features of the model that make me hesitate to accept the result. Let me share what I found.

One clue to the cause of the recession may lie in the fact that it is very concentrated in a few sectors, which are, moreover, not the ones usually affected by business cycles. Such cyclically sensitive sectors as motor vehicles, electrical machinery, and primary metals are still showing increased or unchanged employment levels after seven years. Food and beverages employment is also still above the control level, as is that in mining, chemicals, rubber, and petroleum refining. Where then is the recession? Of the 459,000 jobs lost relative to the control solution, fully 409 are in the "commercial" sector, which covers trade, finance, and services. Another 11,000 come in stone, clay, and glass; another 15,000 in apparel, and 14,000 in printing and publishing. Such a recession is clearly unusual and prompts a closer look at the mechanism causing it.

In the model, that mechanism begins with the import equations. Those equations are of the following form:

$$\ln\left(\frac{TM}{DP}\right)_t = a + \sum_{i=0}^{6} w_i \left\{ \begin{array}{c} \ln (PM/PGPO)_{t-i} \\ \text{or} \\ \Delta \ln (PM/PGPO)_{t-i} \end{array} \right.$$

$$+ \sum_{i=0}^{6} q_i \ln S_{t-i} + \sum_{i=0}^{5} s_i \, \Delta \ln S_{t-i}$$

$$+ \sum_{i=0}^{6} r_i \, \Delta \ln SM_{t-i}.$$

TM is total imports of the products of the sector; *DP* is their domestic production; *PM* is their import price; *PGPO* is the price of the corresponding domestic product; *S*, "sales" is *DP* + *TM* less the sales on the diagonal of the input-output matrix; and *SM* is the inventory of the product; the *w*, *q*, *s*, and *r* are distributed lag weights.

The long-run price elasticities are the sum of the *w*s when they apply to the logarithms of relative price. In seven cases, however, they apply to the first differences of these logarithms, so the long-run elasticity is zero. Bearing that fact in mind, we find the following long-run elasticities: metal mining, 5.8; steel, 3.2; nonferrous metals, 1.3; nonelectrical machinery, 1.0; electrical machinery, 0.7; fabricated metal products, 0.2; automobiles, 0.0; other transportation equipment, 0.0; instruments, 0.0. These results run directly counter to those of other researchers who found the highest elasticities for the finished goods and the lowest for the raw materials. A number of other zero long-run elasticities are found, such as those for food, textiles, paper, chemicals, and petroleum refining. Together with automobiles, these sectors accounted for half of the initial drop in imports. Naturally, the effect fades out after a few years. Since changes in terms of trade should have a *permanent* effect on the ratio of imports to domestic production, that permanence should be insisted upon by the *form* of the function.

The opposite problem arises with the sum of the qs, the weights on the logarithms of the levels of output. All but two products have positive sums of qs, which imply that an increase in sales permanently increases the ratio of imports to domestic production. Generally, large economies have smaller import/production ratios than do small economies, so one would expect that the sum of the qs should be slightly negative. None are negative; twenty-five out of thirty-five are over 1.0; eleven are over 2.0; and four, including those for commercial and stone, clay, and glass, are over 3.0. Such a high elasticity implies that enough growth in "sales" will eventually wipe out the domestic industry. If, for example, the elasticity is 3 and imports are initially 20 percent of domestic production, a doubling of "sales" will push up imports so much that domestic production is reduced 4 percent. A second doubling will reduce it to only 37 percent of its initial value. There is, moreover, a strong correspondence between the sectors with high sales elasticities and those with large employment loss in the impact study. Perhaps these equations have attributed to "sales" effects that should be attributed to reduction in trade barriers, to improving quality of products manufactured abroad, or price differentials not picked up by the rather crude price series. Clearly such equations are unacceptable for long-term forecasting and even in medium-term impact studies they may produce spurious effects.

The first difference of the logarithms of sales appears in only eleven of the thirty-five equations, and in all but two of these the weights are all negative. That again runs contrary to expectations that a domestic boom would produce a temporary increase in the ratio of imports to domestic production. Are these negative terms perhaps used by the least-squares fitting process to offset the short-term effects of the spurious coefficients on the level of sales?

Finally, I must confess that I find the reported results for the commercial sector arithmetically inconsistent with the import equation given for the sector. In the first year, output of this sector *de*creased \$.30 billion (p. 415) while imports *in*creased \$.10 billion (p. 412), so "sales" must have *de*creased \$.20 billion. According to the import equations for this sector (p. 90), imports in the first period could differ from the control solution only by the effects of sales and output and they are an increasing function of both. How then can imports go up while both output and sales go down? If it were my model, I would strongly suspect an error in the program. Is there some peculiarity in the treatment of trade margins on imports?

Let me conclude by repeating that, though I am doubtful about the results of this foreign trade analysis, I greatly admire Preston's achievement in constructing a model so thoroughly integrated. I hope that my comments can be helpful to the model's masters in the continuing task of refining and improving it.

Reply

Lawrence R. Klein

Clopper Almon finds the results of the 10 percent (across-the-board) increase in import prices to be counterintuitive, but I will stick by the Wharton model results for this case and argue that the depressing effect of external price rises is quite realistic as well as being very significant.

He says, "One would expect such a measure to have a short-run stimulative effect on the economy, but after a few years, the employment level should return to what it would have been without the stimulus, and real GNP should be smaller."

With regard to the ultimate movements, we are in agreement, after experimentation, that real GNP should be smaller — as a result of the external price increase. I do not, however, find reason to believe that the employment level should return to what it would have been in the absence of employment-creating policies.

The Wharton model used for this study and other Wharton Econometric Forecasting Associates models have the property that if the economy undergoes external price disturbance, there will be a deflationary reaction in the United States. If prices are raised from outside the economy, we should look for an inverse correlation between production or employment and price change. In the case of domestically imposed expansion, we should find a positive correlation between production or employment and the price change. These are, to some extent, the expected results under normal circumstances.

An externally imposed price increase (the case of tariffs) causes price indexes for final purchases to rise. The normal reaction is for physical demand to contract, the degree depending on the various price elasticities of demand. Falling real demand manifests itself in the deflator's rising faster than the value of nominal output; so the deflated (or real) value declines. On a large scale, this is what has happened in the U.S. economy during 1974–75 under the burden of the embargo, followed by high cartel controls on oil prices. Similar results were found when proposed value added tax systems were seriously being discussed.

Because of the way the GNP deflator is computed, we may find an initial lowering of the overall deflator when import prices are rising. Other price indexes show more familiar results — higher tariffs; higher domestic prices. Eventually, the results for the GNP deflator change sign.

What seems puzzling to Clopper Almon strikes me as being quite plausible. I would stand by our results, apart from the biased tendency of the commercial sector to capture most of the shift of employment. That sector's response equation has to be reestimated, but that does not invalidate the general size of the findings for the economy as a whole.

Comment

Larry J. Wipf

Progress in the current round of Multilateral Trade Negotiations (MTN) will require resolution of a number of key policy issues. Difficult economic and political decisions need to be made concerning the type of tariff formula which best serves U.S. interests, the particular industries which should be exempt from tariff cuts, methods of achieving reductions in nontariff barriers to trade, safeguard mechanisms to smooth adjustments induced by trade, and appropriate compensation of those who experience losses due to trade liberalization.

Sensible policy formulation in the MTN requires knowledge of the costs and benefits of specific changes in international trade policy. To be useful this information must be available at a fairly disaggregated level. Of course, policy formulation involves much more than just economic analysis. Yet without basic economic research, economic factors cannot be appropriately weighted and it is difficult to identify U.S. interests. With this recognition, the Department of Labor sponsored two major studies—one by Baldwin and Lewis and the other by Cline, Kawanabe, Kronsjo and Williams—of the effects of multilateral reductions in trade barriers on the U.S. economy.

These studies provide detailed industry estimates of the effects of alternative types of tariff-cutting formulas on U.S. imports, exports, exchange rates, consumer prices, domestic output and employment. They also contain estimates of the consequences of reducing certain nontariff barriers to trade. Baldwin and Lewis provide particularly detailed estimates of the employment impacts. These are available for some 350 industries and are also broken down by skill group and geographic location. The study by Cline and others adds to this information by providing detailed estimates of trade and employment impacts on the United States and other major participants in the trade negotiations.

These studies mark an important step forward in assessing the gains and losses entailed in trade liberalization. The level of industry detail and the emphasis on employment impacts greatly surpasses that of earlier investigations. In previous negotiations economic analysis entered the decision-making process in a fairly aggregative form. Most studies covered only broad industry aggregates or a few selected industries. The sector studies were supplemented with detailed institutional information and advice of industry experts. While the advice of these experts is very useful in any negotiation, the Baldwin-Lewis and Cline studies greatly add to this information by directly estimating the consequences of multilateral tariff cuts on both the export and import-competing industries and by taking into account interindustry effects and interactions with the rest of the economy.

The results of these studies are directly relevant to a number of policy decisions in the MTN. For example, the examination of alternative types of tariff-cutting formulas is of aid in determining whether the United States should strive for uniform tariff reductions or some form of a harmonization formula as proposed by some of our major trading partners. It is also valuable in determining whether a tariff floor should be adopted below which existing duties would not be cut. The estimates of who gains and loses from reductions in trade barriers and by how much is useful in determining which industries may require longer staging of tariff cuts, less than full formula cuts, or complete exemption from tariff cuts. The studies are also important in assessing the values of specific trade concessions on the part of our trading partners and in appraising the potential acceptability of various proposals to our major trading partners.

These studies do not provide all of the analysis needed in the negotiations. Moreover the results of this research are not, nor should they be, the sole determinants of the U.S. position in the MTN. As stated earlier, though policy formulation involves much more than just economic analysis, these studies provide detailed information which should be useful in formulating U.S. policy. This information is supplemented by other studies initiated by the Bureau. These include detailed industry studies involving steel, motor vehicles, footwear, chemicals, electronics and sugar as well as specific studies of labor adjustment costs. Examples of this research have already been presented in previous sessions of this conference. Together these studies provide policy makers with important inputs for appraising specific policy issues in the MTN.

Comment

Harvey E. Bale

Given the problems associated with the slow economic growth of the United States and other industrial countries in recent years, it has become difficult for the United States and other governments to press ahead with the Multilateral Trade Negotiations (MTN). A number of governments have been under pressure to take import-restraining measures to stimulate lagging production and reduce high unemployment in politically and economically important sectors. In the United States, although the Trade Act of 1974 sets as a prime purpose of the MTN "to foster the economic growth of and full employment in the United States," many leaders of the American labor movement today believe that trade liberalization would have the opposite result.

Therefore, those of us in trade negotiations have a great interest in the studies commissioned by the Labor Department to examine the trade and employment effects of general tariff reductions in the MTN. These can provide some objective indication of whether there might be significant adverse effects on labor markets or exchange rates of our efforts to negotiate significant reductions in tariff barriers.

Value of the Studies to Negotiators

Both the Baldwin-Lewis and Cline et al. papers arrive at similar results, viz. across-the-board tariff reductions do not appear to result in severe adjustment problems in the labor and foreign exchange markets (with qualifications regarding product coverage of the tariff formula).[1] These results are quite useful from the viewpoint of indicating that labor-adjustment problems appear to be small relative to the resource reallocation benefits of major tariff reductions. Further, the studies appear to present the extreme case for adverse effects of the tariff reductions since actual reductions will be staged over a period of five to ten years. The models have a further usefulness in that during the process of negotiations and after the MTN, actual tariff reductions (along with exceptions) resulting from the negotiations can be plugged into the models to obtain an assessment of the sectoral and overall effects of the negotiated packages.

Baldwin and Lewis provide additional useful information for negotiators by identifying detailed product areas for the 367 industry input-output table that show marked negative, as well as positive, employment effects in the United States.[2] This information is helpful, in conjunction with analysis by government and private commodity experts, in identifying areas of concern that may require special treatment in the MTN.

Cline et al. arrive at the interesting conclusion that none of the alternative tariff-cutting formulae that may be considered appear to require great adjustments in the labor markets of the various countries applying the tariff formula, even though they have different results on the depth of tariff reductions and increase in trade. This conclusion could have a beneficial effect on the negotiations by indicating that a reasonable basis for compromise exists between the current strongly held positions of major trading partners regarding the choice of a tariff-cutting formula. For its part, the United States would like to see significant reductions at all tariff levels. Another major country sees its interests served by elimination of low duties and lesser reductions in high duties, while yet another bloc of countries thinks that high duties should be reduced substantially leaving low duties basically unchanged. The Cline study adds a substantive element to the discussion that should lead to a compromise tariff-cutting approach.

Of course, these studies cannot be used as the principal inputs to policy decisions. They will be supplementary to the information the government receives from private sector advisers and government commodity experts. In the United States we have a very elaborate system for obtaining information on the sectoral effects of policy changes from almost a thousand private sector advisers drawn from industry, labor, and agriculture.

Weaknesses of the Models

There are several technical difficulties in the data underlying the models associated with the insufficient degree of disaggregation in the elasticity measures and faults in the tariff and trade data.[3] Some of these probably can be solved. However, there are several other weaknesses that seriously impair the utility of the models as guides for the negotiators.

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[1] Stern [3] also finds small overall net job changes relative to total employment as a result of formula-based tariff reductions in the industrial countries.

[2] Stern [3] also shows detailed (3-digit ISIC) sectoral employment results of all of the GATT Tariff Study countries assuming flexible exchange rates.

[3] First, the elasticities used are too aggregative and are frequently too dated for use in detailed tariff negotiations. Second, the data generally used in the studies are for 1971, which was an abnormal year for trade relations (the U.S. dollar being revalued relative to some other major currencies). While it would be preferable to use the 1974 GATT Tariff Study data tapes now available, the tariffs contained in these tapes are higher than many rates actually in force since 1972 for Japan, Canada, and Australia. These countries have made many tariff reductions that they are not legally bound to maintain and that, therefore, are not shown. Finally, U.S. imports were artificially allocated to fit the BTN product categories in 1971. These allocations were frequently erroneous and are being corrected. The same problem exists for Canada, which, too, does not have a BTN classification scheme for its tariffs.

One of the more important weaknesses in both studies is that nontariff barriers (NTBs) are ignored, except for those quantitative restrictions in developed country textiles and variable levies on imports of agricultural products in most European countries (most notably the EEC and Sweden).[4] However, types of NTBs such as product standards requirements, subsidies, government procurement, and quotas abound to such an extent that the elimination of these trade barriers is as important as tariff reductions in the MTN. The trade and employment results of negotiations in NTBs could swamp the effects of tariff changes. Also, failure to liberalize NTBs would make tariff changes in many areas meaningless. The omission of most NTBs in the Baldwin-Lewis and Cline studies provides a source of upward bias in the estimates of the trade changes likely to occur as a result of tariff changes. It should be added that much more work is needed to evaluate the effect of NTBs on trade flows.[5]

A second weakness in any trade and employment analyses such as these is that there has been a reorientation in the goals of governments in trade negotiations. The trade and consumer welfare changes that Cline uses to define the preference functions of the industrial countries are inadequate. In fact, representatives of the major countries in the MTN deny that trade balance changes are now a major consideration in fixing their negotiating positions.[6] Today governments do not seek simply a balance of concessions (or, more specifically, a balance of changes in trade flows), but a final set of arrangements at the end of the MTN under which access for sales of their products in foreign markets is "equal" to the access granted to foreign products in their home markets. Practically, this means that some countries may ask other countries to make greater concessions than would be called for according to the "benefits" received by the latter. The rationale for this is the view that a few developed countries and many relatively prosperous less developed countries have obtained a free ride in past negotiations (via the Most Favored Nation principle) by pleading the existence of special circumstances (underdevelopment, foreign exchange needs, and so forth). Accordingly, they are expected to try to catch up in the liberalization process under the threat to deny their exports major concessions in this round of negotiations. The measurement of equivalent competitive opportunities will have to take into account several conditions — e.g., roughly equivalent tariff levels, similar rules for product standards setting, and similar rules for foreign bidding on government contracts.

Despite the drawbacks that I have suggested above, the two models discussed here provide useful, albeit incomplete, frameworks for evaluating results of the MTN. There are in fact other policy options to which these models could be applied. They might be used, for example, to study the probable effects on trade and employment of a free trade area between the United States and Canada — an agreement the president is encouraged to negotiate under the Trade Act of 1974.

Literature Cited

1. Johnson, Harry G. *Trade Negotiations and the New International Monetary System*. Geneva: Graduate Institute of International Studies, 1976.
2. Lowinger, Thomas C. "Government Procurement of Foreign Goods in the United States and Europe." Mimeographed. 1973.
3. Stern, Robert. "Evaluating the Consequences of Alternative Policies for Trade Liberalization in the MTN." Mimeographed. 1977.

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[4] Errors are committed in the studies in the handling of the textile restrictions. For instance, Baldwin and Lewis exclude textile products from their calculations because, they claim, the present Multi-Fiber Arrangement (MFA) would prevent imports from responding to tariff changes. Yet MFA quantitative limits only apply to imports of developed countries from some LDCs. They do not apply to intradeveloped country trade. There is much current and potentially greater trade here affected by tariffs only.

[5] There is only one analysis that I know of on the trade effects of government procurement programs that increasingly affect trade as governments increase their purchases in relation to GNP [2].

[6] See [1, pp. 33–34]. Johnson attributes this attitude to the current system of flexible exchange rates.

Comments from the Floor

MR. DEWALD: There will be an opportunity for a few brief questions from members of the audience. Who will throw the first stone?

MS. KRAMER: Helen Kramer, United Auto Workers. My question is addressed to Professor Baldwin. I would like to know whether any tests have been done on the 1967 input and output table for its validity today, in light of the changing technology that has a relative price effect.

MR. BALDWIN: Isn't it right, Wayne, that there are some estimates of changes in those over time? This is my co-author.

MR. LEWIS: Yes. There have been studies made of changes over time in input-output coefficients; and they do change over time. The input-output tables have been updated to at least 1970 to my knowledge; but 1967 is the most recent year for which the detailed 367-sector table is available. So input-output coefficients may well have changed since then, but they are the most recent data available to us.

MS. KRAMER: So then I wonder how valid the results are.

MR. ALMON: May I comment that a group at the University of Maryland, working at a 200-sector level, has just completed an update to 1974. This would be available at a 200-sector level, if Mr. Baldwin wanted to use it.

MR. BALDWIN: That is very good. The point to be made is that you don't know which way the bias would go. It may show a better or a worse picture; I don't think there is any a priori knowledge that it will go one way or another.

MS. KRAMER: That is the problem, though. You are going to show conclusions on which, presumably, our trade representatives are going to take positions. If you don't even know the direction of the change, what kind of a guide is that to policy makers?

MR. LEWIS: Well, the comment has already been made that the use of the 1971 trade data for the U.S. does bias the results of our study in the direction of showing an unfavorable effect on the U.S. trade balance. While we don't know the direction of the bias in using outdated input-output coefficients, we do know that we would have estimated a much more favorable trade balance as a consequence of cutting tariffs, if, in fact, we had used the updated trade data.

MR. DEWALD: Next, please?

MS. JAGER: My name is Elizabeth Jager. I work for the AFL-CIO. My principal comment is that for two days now, the more indecisive and incomplete and insufficient the data, the firmer and more dogmatic the policy conclusion. I find this rather shocking. I would think that people would be very hesitant to advise public policy makers on the basis of the theoretical and rather unrealistic models that I have been listening to. The more sophisticated the mathematics, it seems to me, the less data seem available to be plugged in.

My second comment is related very much to what Helen Kramer was asking: it seems to me that most of what Professor Baldwin has been talking about is done away with by the facts of life in the world in which we now live. In the years since these economists started to play this very interesting, and, I think, highly sophisticated game, nations like Brazil, for example, have put 100 percent import deposit rules on imports of sophisticated equipment. The deposits must be left there for one year, bearing no interest. The result of this system has very little to do with any of these models. But the result is a loss of jobs in sophisticated industries across the board in the United States. This occurs with the agreement, I might add, of U.S. negotiators, who have been advised by people using the type of information the models provide.

In the same period of time, I think it is fair to mention the fact that there has been a change in the value of currencies. A great deal of trouble has developed. Sweden has put global quotas on shoes outside of the GATT agreement. Japan and the EEC have trade restraints, and on and on and on. All this piling on of barriers has occurred on top of barriers that were in effect at the beginning of the exercise that is known as the "Tokyo Round."

Given these conditions, I find it very hard to be patient, not with the fact that these very skilled and intelligent people are pursuing their academic pleasures; I think that is great. I do have, however, a very different concern. Somebody asked me yesterday why I kept bringing reality into the discussion. The reason is that very real people are affected.

With that introduction, I would like to ask two questions. My first question: Has any member of this group examined, not the one-volume "telephone book" that Professor Klein's Wharton group has produced, but the four-volume International Trade Commission book on non-tariff barriers to trade? I don't think that book is an exhaustive study. It includes only the barriers American business was interested in removing — not what I think the policy makers would be interested in seeing. My second question is — and it is an honest one, because I think the Wharton model may have predicted it — Has any member of the panel used, even in a short-term forecast, any model that predicted that we would have, at this moment, an 8.1 percent unemployment rate?

MR. DEWALD: I wonder whether I could ask each of the authors to respond to those questions. Let's start with Professor Klein.

MR. KLEIN: No comment.

MR. BALDWIN: In response to your two questions, respectively, yes and no. We know the non-tariff barrier study by the National Trade Commission; I have written a book myself on the subject at Brookings, trying to estimate the impact of NTBs. These are very hard to quantify. But it is true that there are a lot of nontariff barriers being erected which, unless we can get on with negotiations in Geneva, may threaten many of the benefits of liberalization that we presently have.

Let me comment also on the unemployment problem. I think you want to take a much different picture of having a trade negotiation when you are in a period of considerable unemployment than when you are not. You may well want to decide that this is not the appropriate time to start cutting duties; or if you do, you say, "We will stage them in or begin them when unemployment falls to some particular level." We find out, for example, when workers are thrown out of jobs, if the general unemployment rate is high, or it is particularly high in their area, that it takes longer for them to get jobs than otherwise; and we hope to take that into account in our estimates, where the local unemployment rate is one of the variables.

MR. DEWALD: Anne Krueger would like to respond.

MS. KRUEGER: Yes. As one of the critics of these models, I feel called upon to say a word or two in regard to Liz Jager's questions. I think that on the one hand, there is obvious disagreement among economists as they are trying to find techniques that are more satisfactory; and in this regard, some of us have to be critical. On the other hand, it seems to me that somehow or other, there are all kinds of interests involved in things like tariff negotiations. There are some things that are going to come out positive and some are going to come out negative for particular interests. It is important to emphasize that all of these papers come up very strongly with a message which I think is fairly robust. These models all come out the same way, as does anything else: namely, if you want to worry about the level of unemployment, you don't look at the trade instrument.

The models don't really have that much to do with aggregate employment but rather with employment in particular industries or industry groups. This is precisely where their value lies; namely, in trying to estimate that there are going to be some people who are better off, some who are worse off, and there can be policy problems in the short run as a consequence of these shifts in labor demand. I would say that the value of Bob Baldwin's or Bill Cline's work is in trying to pinpoint industries where there will be some people who might be worse off. The question is identifying those cases, limiting the adverse effects, and getting the maximum gains from trade negotiations. Simply because no model captures every aspect of reality, it is unfair to say we shouldn't use models at all, and be satisfied with any seat-of-the-pants estimate. Quite the contrary, the models give us some guidance as to where to look for the kinds of policies that can offset negative effects and can accentuate the positive ones, so that employment impacts, such as they are, can be reasonably anticipated and handled at the macroeconomic level.

(APPLAUSE.)

MS. JAGER: Why are you clapping? May I make a comment in response to that last comment?

MR. DEWALD: Yes. Could you speak into the microphone, please?

MS. JAGER: Now, I know that this is your belief, and I know that it is the dogma, and I know that it is your theory. I have spent 25 years looking at this situation. What you are talking about simply has not happened. Over a period of time, imports have had very much to do with American employment. So have exports. So have operations of firms outside the United States. The very simplistic, theoretical models assume that policy actions must be of an autonomous character rather than interrelated with what is happening in the world. That is really what you are prescribing. The only direction your prescription suggests is to increase trade, as if trade in itself were of benefit, without regard to some very real costs that are involved.

That is not the way the world works. I am sure you are sincere in your comments about the escape clause. I have been studying these problems for a long time. That is simply not what happens in the real world. Professor Baldwin told us that the jobs in New England are only in shoes, leather and textiles. That is not what happened there, either.

We work for people who have lived with this situation. They are out of work. They don't believe that all is well. I used to believe the theory, and go along with a simplistic freer trade policy prescription. But I had to leave it, particularly in the year 1970, when it was demonstrable that the results that were predicted had not occurred.

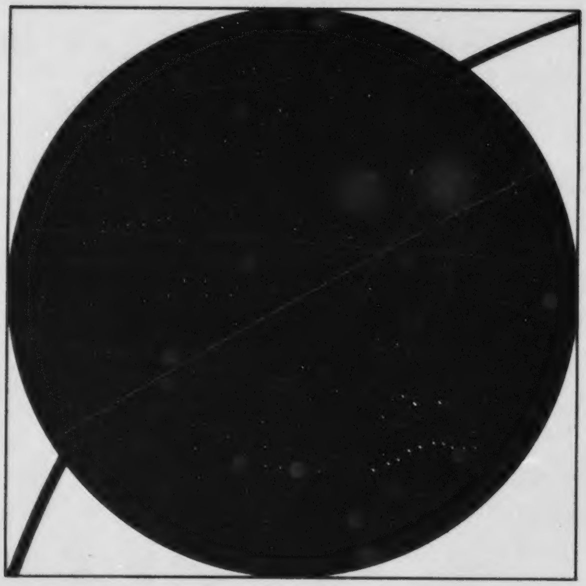
What I am saying is that your models are interesting, but they are not sufficiently predictive to be used as a basis for policy making. And I think that in many instances, they have caused, or accelerated, some of the worst economic distortions that the world has ever seen.

(APPLAUSE)

MR. DEWALD: Additional points can be made at the panel this afternoon.

Part Seven

The Value in Policy Making of the Department of Labor Research on the Impact of International Trade and Investment on U.S. Employment



International Trade and Employment: Issues for Research and Policy

Michael H. Moskow

Although we are already a day and a half into this conference on trade policy research, it may be good to review the reasons for the Department of Labor's interest in trade and foreign investment issues, what our present involvement is at the policy level, and what we see as continuing issues for policy makers.

Why is the Department of Labor concerned about trade and foreign investment? The answer is simply that trade and foreign investment are of large and growing significance in the lives of U.S. workers. Let me just repeat some facts with which you are no doubt familiar. From 1960 to 1975, total U.S. exports rose from 5.5 percent of GNP to 9.8 percent of GNP. Similarly, total imports over the same period grew from 4.6 percent of GNP to 8.4 percent of GNP. Looking only at *merchandise* trade and relating it to total final goods output — mining, manufacturing, and agriculture — we find that merchandise exports grew from 7.8 percent of total goods output in 1960 to 15.8 percent in 1975. Imports grew at an even faster rate.

A similar picture can be seen in the area of foreign direct investment, although here the data do not go back very far. In 1975, capital expenditures of foreign affiliates amounted to $26.7 billion or 18 percent of gross fixed U.S. nonresidential investment. This is a rise from 11 percent in 1966.

What is the significance of these changes? I do not wish to give the impression that all these changes are necessarily bad, or necessarily good for that matter. But the growing size of trade and foreign investment has the potential for a significant impact on the jobs and real earnings of U.S. workers — subjects of natural concern to the Department of Labor.

How can trade and foreign investment affect employment and real earnings? Changes in international economic policy can affect the level of aggregate employment, at least in the short run. Real earnings can also change because of changes in consumer prices and because of the change in the industrial and occupational mix of jobs. We have, for example, estimated that more than 4 million people work in jobs different from the ones they would have had in the absence of international trade.

In addition to these changes in real earnings of a more long-term nature, there are short-run earnings losses and gains due to changes in employment in particular industries. Workers displaced because of imports may lose income because of their time out of work and also because they may not be able to find jobs as good as the ones they lost. Similarly, exports may shorten the unemployment spells of others as they are absorbed by expanding industries. I do not mean to downplay these earnings losses and gains by referring to them as short run, for they can be significant in relation to lifetime earnings. For example, the effect of displacement may be felt for a long time, such as in the case of labor force withdrawal or a change in demand for particular skills.

It is, therefore, not difficult to understand why we in the Department of Labor have a serious interest in international economic developments. It is also not surprising that we have a significant and increasing involvement in the formation of international economic policy. The Department of Labor participates actively in the wide range of interagency committees and subcommittees that have responsibility for making recommendations to the president on trade policy. These include the Multilateral Trade Negotiations, escape clause cases, unfair trade practices, the Generalized System of Preferences, East-West trade, the Multifiber Textile Arrangement and negotiation of steel agreements, to mention a few. Related to these are the activities of the General Agreement on Tariffs and Trade, Organization of Economic Cooperation and Development, United Nations Committee on Trade and Development, the International Labor Organization and other United Nations bodies concerned with trade, investment and transfer of technology, and other matters related to the North-South dialogue. The secretary of labor is a member of the Economic Policy Board, the East-West Foreign Trade Board, and the Council on

International Economic Policy, all of which deal, at the highest levels, with major issues affecting trade and foreign investment.

A particularly important aspect of our current responsibilities is the program to facilitate the use of advice and information from the labor sector on issues being negotiated in the Multilateral Trade Negotiations. The labor advisory committees, with a roster of about 160 union officials, are active and vocal and provide the Department of Labor and the special representative for trade negotiations with the views of organized labor on the entire range of issues covered in the trade negotiations.

One important area in which the Department of Labor has recently been given expanded responsibility is trade adjustment assistance for workers. The Trade Act of 1974 gave the Department of Labor principal responsibility for determining eligibility of workers for assistance, and liberalized the criteria for assistance as well. The program is now running at the rate of 150,000 certified workers a year, and is currently budgeted at $240 million annually, over and above the unemployment insurance that workers would be entitled to. This program has important policy implications. If trade adjustment assistance can truly ease the transition for many displaced workers, and if there is confidence that it is administered fairly, the climate for a liberal trade policy will be improved.

The Department of Labor is then very interested and involved in trade and investment policy. Perhaps because of this, we are aware of the problems that continue to make policy formation in this area very difficult.

One problem, which we in the Department of Labor feel particularly keenly, is how to weight the respective benefits or losses to consumers, to workers, and to other producers when trade barriers are under consideration. For example, how much should society be willing to pay to preserve a particular job if it is not feasible to compensate fully a worker who is displaced or to place him in a comparable job. Economists have not offered us much guidance on this score.

Now I don't think I'm revealing any secrets by saying that questions of trade policy are usually not decided at this rather abstract level. But the fact that we economists don't completely understand the issue may limit the value of the advice we give. It may even be that the so-called political factors that economists tend to look at with disdain capture dimensions of costs that are usually left out.

Beyond this basic question of how to balance off gains and losses, there are other kinds of information involving somewhat less cosmic issues that would be very useful in forming trade policy. For example, we don't really know at this point what is the best way of helping trade impacted workers. Will higher trade barriers in the industry help the right people, for example? If a tariff is raised six months or a year after layoff, will the workers still be available for rehire or will they have drifted away to other areas? In other words, we don't know how prompt policy changes must be to be effective. We also don't know whether higher trade barriers will cause the rehiring of displaced workers or simply new hires by firms in the industry that are still prospering.

Trade adjustment assistance is frequently offered as the alternative to higher trade barriers, but hard evidence on the effectiveness of trade adjustment assistance is not yet available, particularly under the program as liberalized by the 1974 Trade Reform Act. Does trade adjustment assistance compensate workers for a significant part of their losses? Do the payments and services ease the transition process? I know that our Bureau of International Labor Affairs has started research on these issues, as can be seen from the papers at the conference, and they should be encouraged to proceed further along these lines.

In most of these questions information on the extent of losses incurred by workers really is paramount. What are earning losses in a particular industry and how do they compare with losses in other industries? It is true that the financial losses alone may miss important psychic aspects of displacement, but knowing the financial losses will be a critical step in policy evaluation. For one thing, psychic costs may well be higher when income losses are higher. In any case, I am pleased that the Department of Labor is pioneering in the area, and I look forward to future results of the research program.

Since we have been discussing areas in which much more information is needed, I should touch on foreign direct investment and U.S. multinational corporations. The conference papers on the subject indicate that the range of uncertainty is now narrowing very quickly with regard to the impact of foreign direct investment on employment and real wages. This is a subject of much public concern and I can only hope that further study will reduce the controversy that the issue evokes.

I have been discussing the kinds of information that it would be nice to have. But can I leave you with any encouraging words that research really affects economic policy? Not frequently enough. This is sometimes the fault of researchers, because their work is not policy relevant, or because they are not effective in communicating their results to policy makers. In fact we probably need people with different skills, let us call them "translators," to summarize key research studies and present them in noneconomist language to policy makers. Policy makers may also be at fault because they don't realize that researchers may have something useful to say on an issue. Sometimes they haven't really communicated the questions that need to be answered, the real policy alternatives, and the interests that are in conflict. We can all probably do much better. I hope this conference and the research behind it has given us a start.

Panel:
The Value of Research in Policy Making

Herbert N. Blackman, Chairman
Robert E. Baldwin
Harold T. Lamar
Calyton Yeutter

MR. BLACKMAN: We are ready to start the post-luncheon session. We are now reaching the real meat and potatoes of the day. We want to find out how all the work that has been discussed in the past two days will help arrive at the important policy decisions. The subject is "What value does economic research have for policy making?"

We are singularly fortunate in the selection of our panelists. First, we have Professor Robert Baldwin of the University of Wisconsin. He has a special role here, because, in a sense, he is at least partly responsible for where we are today in the field of trade, having been one of the chief economists for the Kennedy Round of trade negotiations.

Harry Lamar, of the Ways and Means Committee staff, also has some responsibility for where we are, as one of the framers of the Trade Act of 1974, which set all these tasks before the trade negotiators.

Finally, we have Ambassador Clayton Yeutter, to whom all of this has been addressed, since he is one of the principal negotiators for the United States in the multilateral trade negotiations. I should note that he has had a distinguished career in law, a Ph.D. from the University of Nebraska, he has been Assistant Secretary of Agriculture, and is now the Deputy Special Trade Representative for the trade negotiations.

We start with Professor Baldwin.

MR. BALDWIN: After some of the comments this morning, I have a feeling I am offering myself as a sacrificial lamb for the Foreign Economic Research group in the Labor Department, but I shall do so. Now, obviously, since I undertook a study attempting to estimate trade and employment effects of the trade negotiations, I believe that they are useful studies. At their present stage of development, I would by no means rely exclusively on them, if I were a trade negotiator. There is still a very important, perhaps dominant, role for the so-called industry experts, people knowledgeable either on the labor side or the management side, who have spent their lives in these industries and have the feel for some of the interrelations that you just can't get out of the numbers that we work with.

Of course, there is sometimes a danger that an industry specialist becomes a bit too identified with an industry, and too sympathetic to its problems, but certainly the experts are highly valuable. I am sure the various advisory groups that we have in the negotiations are very valuable to the negotiators, and they will want to consider their advice.

The type of economic studies that we now have will, I think, become more and more valuable as we gain more detailed knowledge about probable trade and employment effects. The studies are simply ways of organizing a large set of relationships, bringing them together, and exploring the implications of these relationships for a particular problem; in this case, cutting tariffs. We in the social sciences are trying to apply the scientific method to the problems we have to deal with and organize facts and relationships systematically in trying to explore or simulate the effects of possible changes in the various policies in which we are interested. We know that we are in a world of imperfect knowledge. But we don't have the option of not doing anything. We have to make decisions in life; one just can't sit and say, "Well, we will do nothing." It is a question of choosing among imperfect alternatives.

These models are certainly imperfect. The advice of various industry representatives is also imperfect. Negotiators should use both at this stage in formulating decisions that must be made. We have a trade negotiation going on. We have agreed to decide upon some tariff-cutting formula, and we must also decide what exceptions to make. How do we do this? Certainly one step is to utilize all the various sources of information available. I think models such as mine are helpful in providing one such information input for the negotiators.

Now, how do we deal with the fact that we don't know economic relationships exactly? We don't know the exact value of the coefficients needed for such an analysis: input-output coefficients change over time; labor coefficients change over time. How do we handle this?

First we do have some experience as to how these changed in the past. For example, it is my view that input-output coefficients haven't changed too significantly over time. When we put the same kinds of broad policies into one input-output table and use another table later on, the results tend to come out about the same.

But more importantly, we undertake various experiments to see how sensitive the results are to changes in some of these relationships. For example, we don't pretend that we know exactly what the import and export demand elasticities are. But we have lots of empirical measures that build up confidence limits on the range of their possible values. In our study, we try to take into account this range that has been estimated by various investigators. We take the highest import elasticities that have been estimated; these imply that lots of imports are going to come in, if our tariffs are cut. On the other side, we take the lowest export demand elasticities that have been estimated. Combined, these import and export demand elasticities tend to maximize the adverse effect on trade and employment in this country. In addition to performing this kind of experiment, we take values for the elasticities that are most favorable to us in trade and employment terms. When you don't have perfect knowledge, you say, "Well, let me put in values for key coefficients that are about as far out as could possibly be plausible," and see what happens. This so-called sensitivity analysis gives an idea of the range of possible outcomes.

To be sure we did not minimize the labor adjustment problem, we tried in our study always to bias the results in the direction of showing the largest employment losses. For example, we used 1967 labor coefficients. Those coefficients decrease over time, as productivity increases; so the adverse effects would even be smaller now. We took one of the worst years we could take in terms of our trade picture, 1971. The reason was mainly because the tariff and trade data collected by the GATT was for that year. But as Bill Cline mentioned this morning, one can try to correct for this bias.*

Now, some of our results may seem implausible to some. If they are implausible, we must try to obtain better empirical estimates of the key relationships. In this regard, I think it is important to try to obtain better direct estimates of the effects of cutting duties. So often, we in international trade, or almost any branch of economics, have to use imperfect data, data that often were collected for another purpose. For example, I have always thought that it was too bad that we did not monitor the tariff cuts in the Kennedy Round. Those were significant cuts: 50 percent in many areas, over a five-year period. I used to say, "Let's try to pick out some of the sensitive industries, on both sides, export and import competing, and try to follow these through; collect the data directly for the purpose we want, and see if we can't pick out just what the effects of the tariff cuts have been."

There are many other events occurring all the time, and you have to try to account for them. But if you focused on some particular industry, I think you would have a better chance of picking up what really is happening. Trace the effects on a particular firm, or on a particular industry. We certainly should do that next time. I hope in this negotiation we make sure the Department of Labor or somebody will try to follow through what happens after we cut tariffs so we can better understand what may happen in the future if we do the same thing again.

A very disturbing development in the trade area is that we now have a wide difference in views held by economists in universities or in nonprofit private research institutions and the staff and the rank and file in the labor movement. These latter people feel that most of what we are doing is esoteric game-playing and really has very little applicability to the real problems they must face.

As Liz Jaeger was saying this morning, in the Kennedy Round, the labor movement did support the tariff negotiations, but they now believe that, because of very stiff import competition and extensive overseas investment by U.S. firms, they have significantly lost in terms of employment. Of course, one big culprit was our overvalued exchange rate. We pay an awfully high price when we do something like that. When our exchange rate was changed, pressure for trade restrictions from some of our import-sensitive industries did weaken. That is one of the reasons we were able to get the Trade Act of 1974 passed. It is a remarkable bill that gives more tariff-cutting authority than we had in the Kennedy Round.

But the gulf is so wide, it is hard to talk without becoming very emotional. If only we could get together with some of the labor people, away from public meetings, and over a period of time, try to resolve issues or find out just what are our differences. Sometimes you say to those against trade liberalization, "Well, what about consumer benefits?" But someone will immediately say, "That is all wrong. Importers don't reduce their prices. You reduce duties and the merchandising people will import lower-cost items. They will buy them instead of the domestic goods, but they will price them the same, and sell them and make more profit. There are no consumer benefits then."

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*William R. Cline et al. "Multilateral Effects of Tariff Negotiations in the Tokyo Round," presented at the Conference on the Impact of International Trade and Investment on Employment, Washington, D.C., December 2 and 3, 1976.

That is an empirical question. Why can't we set up studies to find out if that is true. Using a methodology on which all agree initially, we could look at particular firms, particular sectors, and try to settle these differences in views.

Does it finally just come down to a matter of value judgments? If you are representing certain people, and you don't want to have them hurt, you naturally push their particular point of view. I am convinced this is not the case in the labor movement. In my opinion they believe that for the good of the country, significant tariff cuts should not be made, and much of our foreign investment should not be made. How can we bridge the tremendous gulf in views? One way may be to have a series of thorough, low-keyed discussions between trade experts in the labor movement and trade specialists from the academic community and nonprofit research organizations that are based on carefully written papers by some of the participants. These papers would be directed at specific questions agreed upon by the participants prior to the discussions. The general way the authors would proceed in answering the questions would also be agreed upon beforehand. In such discussions, which could perhaps be sponsored by the Labor Department, we would develop a basis for better understanding whether trade liberalization really does serve the national interest.

MR. BLACKMAN: Thank you, Bob. Now, we will turn to Harry Lamar of the House Ways and Means Committee staff.

MR. LAMAR: Thank you. I am very pleased to be here this afternoon. I noticed that in most papers presented to the conference, there was a general disclaimer that the authors were not speaking for the Department of Labor. I would like to add that I am not speaking for the Department of Labor or even the Ways and Means Committee this afternoon.

The question of whether economic research has a value to the trade negotiations, I suppose, could be answered in two ways. One is "none," in that the negotiators have their minds made up as to the ends of the negotiations and they don't really want to be bothered by the answers that research might yield. And the other answer is, "It depends on what type of research can be done."

I recall that in the preparation for the Kennedy Round, a study was being made in the Department of Commerce of the utilization of the 50 percent authority for reductions in tariffs. The study was not done in the usual way in terms of economic analysis and model-building, but rather was based on the opinions of commodity analysts as to what would happen if the full 50 percent basic authority of the Trade Expansion Act were used. The analysis engaged the commodity analysts in guessing what would be the increase in imports and the increase in exports if most of the industrialized countries reduced tariffs by 50 percent. The study made the basic assumptions that there would be no major inflation, no wars, and all of the other assumptions that normally would be made; and the results were aggregated. The study, being made in the mid-65 period, indicated that there would be a trade deficit in the early 1970s if the full Kennedy Round tariff reductions were made. That study was very shortly shelved on the grounds that it was not very scientific, because the estimated trade flows were not expressed in terms of the appropriate elasticities. Secondly, it was shelved because it came up with the wrong answer.

Events proved the study to be correct; probably for the wrong reasons, but nevertheless, we did experience a deficit in the early 1970s. And I have, as an erstwhile economist, been unable ever to understand why, when a commodity analyst looks at market conditions and changes therein, and makes estimates of trade flows, his estimates aren't just as valid as an economist's estimates, which utilize a rather sophisticated set of assumptions about elasticities.

I would suggest that if economic research for the trade negotiations is to be meaningful, we should have a little wedding of what commodity analysts can tell us about what is going to happen in world markets and what economists can tell us about what is going to happen by using the analytical tools that are available.

I have attended the conference yesterday and today. I have listened to most of the papers. I have tried to read them. I must confess, it has been a few years since I have been in the university, and the meaning of some of the analyses escapes me somewhat. Being confronted with immediate trade impact problems at times, I am not always able to follow all of the complicated formulae that economists these days use in arriving at conclusions.

But I have some rather practical conclusions about economic research and how it applies to the formulation of trade policy, at least as it is seen in terms of developing trade legislation.

It is, I suppose, a cliché to say that the value of economic analysis is directly proportional to the relationship of the assumptions to the real world. I find many of the papers at this conference lacking in this respect. Secondly, the analysis must be understandable to the official who is to apply the results in forming policy. Thirdly, and most important, it must answer the right questions.

All of us realize that the trade negotiations are based on conventional economic theory—that there are comparative advantages in producing and exchanging goods in world trade—and that the correct allocation of resources is a *good* thing. Therefore, it is not surprising that most economic research papers result in a finding that reduction in trade barriers does result in a higher income and output based on an improved allocation of resources. There will be an increase in the actual welfare stemming from the economic operations affected by such reductions in trade barriers.

But after reading most of the papers, two things occur to me. I am not so sure about all of these measurements of job impact. I am not sure that we can measure what jobs are due to exports; I am not sure we can measure what jobs are lost by importing competitive commodities. I am not even sure that this is the right question to ask.

I was interested to learn, in the steel paper, for example, that if we had had free trade in 1968 to 1973 there wouldn't be all that much of a job loss. But I think what organized labor is concerned with is not the immediate impact of job loss, but what is happening over the long run to *job opportunities*. And this has to do with more than just the current trade negotiations. I think there is a real question, and I think it was posed yesterday in the luncheon talk by Murray Finley, that labor is concerned with the health of the productive industries in the United States. It has been said in congressional hearings, and I think it is a very real concern, that we may end up selling other people insurance, and other services. The question is, "How much of a productive goods industry are we going to maintain in the United States?" And I believe that this is one of the questions that economic research should address.

I can think of one example in the trade negotiations that involves such a question; and that is the request by the developing countries for special and differential treatment in all aspects of the trade negotiations. We have a generalized tariff preference scheme. It is working well, or not, depending on your point of view; but nobody has ever really developed economic proof that a special tariff preference system is of long-run economic benefit to developing countries. Just the opposite, as Bob Baldwin knows. But more than that, the request of the developing countries for special and differential treatment in all aspects of the trade negotiations in Geneva raises the very fundamental question of whether the negotiations in Geneva are going to result in a trading world based on the principle of nondiscriminatory most-favored-nations treatment, or whether it is going to arrive at a multitude of arrangements based on special economic but also political interests of developing and developed countries. And make no mistake about it, all of the efforts of the developing countries are aimed at the transfer of resources. They have made that clear over the period of fifteen to twenty years. What are the resources that are talked about in terms of transfer? It is the productive resources: who produces the goods that are exchanged in international trade? Their answer is that they would like to produce a lot more. The question that remains is, "What are they going to produce?"

Goods, both raw materials and manufactures, can be produced in all countries, if the negotiations can result in a trading system which treats each economy fairly in terms of its own economic advantage. I think it is about time that we *returned* to the principle of comparative advantage in economic relations world-wide. I would suggest that many of the actors in these negotiations see the ends a little bit differently, in that the United States should be willing to transfer many of its productive resources abroad in order to "readjust the balance" between the developing countries. However, the other industrialized countries are not willing to do so, but are willing, for appearance's sake, to reach arrangements on the basis of bilateral considerations with the developing countries, impelled as much by narrow political interest unrelated to building a viable trading system.

I think some of the questions that should be addressed in economic research might highlight such developments and lead to different conclusions as to appropriate U.S. policy. Thank you.

MR. BLACKMAN: Thank you, Harry. Now, we turn to Ambassador Clayton Yeutter, Deputy Special Representative for Trade Negotiations.

MR. YEUTTER: Thanks very much, Herb. It is nice to be here. I am sorry that I haven't had a chance to attend some of the sessions, particularly the one this morning, which, I understand, provided some fireworks. I have had an opportunity to read some of the papers and I will try to give you the flavor of the issues as I see them from the standpoint of those of us on the negotiating scene, even though I do so as a lame duck negotiator with an anticipated departure date of January 20. Because of that, what I have to say may not be all that relevant in terms of the forthcoming multilateral trade negotiations. You can qualify my comments appropriately.

It is easy to be a critic of economic research. I have spent a good many hours of my lifetime being a critic of my fellow economists and agricultural economists. This summer I addressed the annual meeting of the Western Agricultural Economics Association and posed some hard questions in this very area of international trade. I tried to indicate the evolution that we might anticipate in the next few years, particularly from an agricultural

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standpoint, and how agricultural economists might more effectively fit into that picture.

I won't cover that area today. But I will say that, notwithstanding the critical comments that I have made of my fellow economists through the years, I don't want them to stop doing research. I don't want to see the Baldwins or the Kleins or anyone else stop working.

The challenge for those of us who are using research, whether it comes from the private or public sector, universities or the government itself, is to interpret it and relate it to the real world. No one will make the argument that a piece of economic research of the broad scale illustrated by the papers discussed at this conference is the real world in every respect. I don't think you will find Professor Baldwin or anyone else arguing that it is. The question is whether those of us who use their work can understand the assumptions that are involved, and then interpret it in the real-world setting in which we operate. If we can't, then maybe we had better go back and have some more economics training. If we can, then we will achieve benefits from the research that they are undertaking.

Of course, we have an obligation to them just as they have an obligation to us. If we feel they have departed too far from the real-world setting, or if we feel their assumptions are inappropriate, or that they are ignoring important aspects of the problem, we ought to say so, and ask them to go back and start over, if need be, or alter their research activities. If we haven't made our own contributions as critics, then we are not very effective in helping them to provide a useful product for us. So there is an obligation for those of us who use the material, and who are critical of it, to help make it more useful.

There have been far too many occasions through the years in which academicians have spent too much time talking to each other. That has been one of my criticisms of the academic community even when I was a part of it. In the almost ten years since I have left the academic community it is still one of my criticisms. Academicians continue to spend a great part of their time talking to or writing for each other, and not enough time communicating with people in decision-making roles, in the government or the private sector. That is hard to correct. All I can say is that we need to work at it. That means academicians should make a conscious effort to spend more time with those who are in decision-making roles and vice-versa.

We in government tend to get heavily wrapped up in day-to-day activities and lose sight of what others might do for us at a particular point in time. We get caught up in high priority short-term issues, in trouble-shooting and dealing with crises, and forget that research is basically a long-term endeavor. We need to sit down and plan ahead as to what we might need in two or three years, but we often fail to do so. Therefore, one can readily criticize government decision makers for not getting organized to use research results effectively.

With this general background, let us focus on the negotiations themselves. One cannot simply take a study by Bob Baldwin or anybody else and plug it into the negotiations. Even though the writers of such studies would like to feel that that is the way it is done, it never happens quite that way. Certainly those research efforts can be influential and, hopefully, will be influential, but there are a lot of other things that get plugged into the negotiating matrix as well.

First of all, anyone with economic training knows that there are numerous variables in this field that cannot be quantified. Someone has to bring the nonquantifiable variables into the picture. This can't always be done in the studies, but must be done at the level of application. Beyond that there are a lot of inputs from other sources that cannot be ignored. Trade negotiations are a political-economic process, not a purely economic process, and somebody has to plug in the domestic political element. This means input from the private sector. We get this through 45 advisory committees with over 800 members, through congressmen and senators, and through direct contact with many organizations, agencies, and private individuals.

Bob, you are getting some of the input this morning that we get every day of the week. So don't feel bad about that kind of input. That is what makes the world go around, and we want it to continue. If people in the academic world—Wisconsin, Ohio State, wherever—are not feeling that kind of input, then they may be operating outside the gamut of the real world in terms of their research. Even if it is critical, this input is important and the academician has an obligation to consider criticism at an appropriate time in the research process.

We in trade negotiations don't always abide by the wishes of the critics. Sometimes we ignore them. Sometimes we try to convince them they are wrong. Sometimes we are convinced that they are right. That is what judgment is all about, and that is why we are sitting in these roles. We are supposed to take inputs from various sources, including academia, plug them into a matrix, and go from there. That is what the policy-making process is all about. Beyond that, there is the matter of negotiating itself—pure and simple horse-trading—where individual skills that have nothing whatsoever to do with economic research are involved.

Before closing, I would like to comment briefly on two issues that have surfaced in the discussion, that is, the area of nontariff barriers and the interests of developing countries. I would particularly like to emphasize the challenge to the economic community of the

North-South dialogue, because in my judgment there is going to be a lot of activity in that area in the coming years.

What has been going on in tariffs may really turn out to be a rather limited or parochial element of the total problem. Nontariff barriers, such as quotas, are a much more important part of the international economic scene today. For example, when one speaks of the principle of comparative advantage, quotas can work against it quickly. We need to know a lot more about the implications of quota programs that are in existence today, and particularly those that may continue after the multilateral trade negotiations conclude.

Beyond that, the implications of providing special and differential treatment for developing countries in various areas of the multilateral trade negotiations is a gigantic area for economic research that must attract a lot more attention in the future than in the past.

I spoke a great deal today about criticism. My only other comment is to note that criticism is often based upon one's own self-interest. I can remember from my days in the Department of Agriculture that I often received comments from farmers that the USDA ought to stop publishing reports of production conditions in the agricultural sector. Now, what those farmers really meant was that if estimates at a given time were for a big crop, they didn't want that published because it would have an adverse impact on prices. But if the estimates were for a small crop they wanted that in six-inch headlines, so that the price would go up. Therefore, "it depends" as to whether farmers criticize government or praise it—and to whether they want government to take a high profile or a low profile. Perhaps the same analogy applies to the research discussed in this conference. Thank you.

MR. BLACKMAN: Bob, do you want to speak to Harry's point about whether research can help us deal with the question of whether the productive base of the United States is being eroded, and whether you could provide research on the issue of special and differential treatment.

MR. BALDWIN: My own feeling is that there is no reason that we can't have some of these negotiations without causing any significant adverse effects on labor. If anyone can show there are some adverse effects, significant ones, then I am for not cutting a tariff in that area. In this country, it is inexcusable to run something like this and cause real hardship. We don't have to. That is not good for the welfare of those people, nor for the community at large.

MR. YEUTTER: Well, beyond that, Bob, I don't see why we want always to talk about avoiding reductions in employment. Why don't we talk about trade negotiations from a positive standpoint, about doing some things that will lead to greater employment? And I don't think we should assume that that is an impossibility.

We have a lot of sectors which have export potential. You mentioned the matter of having an overvalued exchange rate. You know, I don't think it is out of stupidity that everybody around the world is investing in the United States today. They recognize the potential of this country, and the great unrest and uneasiness of investment elsewhere in the world. I think there is great potential, Bob, for actually expanding employment as a result of trade negotiations.

MR. BALDWIN: I think that is a good point. As to the LDC point, I think I fully agree with that. I don't think preferences are in their long-run interests. I think it is going to turn out that they are going to expand their manufacturing and exports less in the long run with these very preferences, which are always associated with all kinds of controls. Look at the Japanese scheme, or the Economic Community scheme, both of which have all kinds of quotas. After a while the management of these schemes will be put on such a technical level that it will be impossible for most people to know what is going on, particularly with all these little quotas. But the end result, I think will be harmful to the LDCs. Tracy Murray of the Graduate School of Business at NYU and I argue in a paper** that the LDCs will gain much more by participating more actively in the multilateral general negotiation. That will bring them more gains than the small erosion in the preference margin that they will suffer.

MR. YEUTTER: We have been telling them that in Geneva, Bob, as you know; but not with great persuasion to date. The LDCs have had such a head of steam on this preference issue for the last ten years or so that it is difficult to view the issue in a straightforward, unemotional way. That was a big endeavor in UNCTAD for a long time.

MR. BALDWIN: It is a matter of faith in UNCTAD.

MR. YEUTTER: You are right. In terms of basic economics, I think it is unlikely that tariff preferences for LDCs will lead to any major benefits for them.

**Robert E. Baldwin and Tracy Murray, "MFN Tariff Reduction and Developing Country Trade Benefits Under the GSP," *Economic Journal* (March 1977), 30–46.

MR. BLACKMAN: Harry, would the Congress like to get in the last word?

MR. LAMAR: Yes; I would like to say that there is a little more involved than just tariff preferences. There are the requests by the developing countries for special and differential treatment in all aspects of the rules of the game; that is, in the agreement on subsidies and countervailing duties; in the agreement on government procurement, or the code on government procurement; in all aspects of the negotiations. And it is how we change the rules of the game to accommodate the developing countries that is really the real question in the negotiations right now.

Sure, there is an issue on how the U.S. and the EEC are going to reach accommodation on the agricultural issue. But aside from that, both in the tariff formulae, and in negotiations on the codes on NTBs, the basic question facing the industrial countries is how they are going to accommodate the request by the developing countries for special and differential treatment in all aspects of the trading rules.

As I tried to suggest in my comments, I think this raises a basic question of whether these negotiations are going to develop a framework for a trading world which more or less runs on the basis of nondiscriminatory, most-favored-nations' treatment, or whether it is going to evolve into a whole plethora of special trading arrangements, and bilateral deals, subject to political forces both domestic and international.

MR. BLACKMAN: Thank you. Comments or questions from the floor?

MR. ALLEN: I am Don Allen from Industry Trade and Commerce, Canada. I have a question which I would like to put to any of the panel. You mentioned the gulf between the economists and labor, the gulf between economists and negotiators, negotiators and labor, and other groups. And yet, in anticipating some of the adverse comments from people from the labor movement, you have indicated that the labor unions are concerned about the long-run health of the economy and union people yesterday said, "We want jobs, not trade adjustment assistance." Yet the research often is showing in this conference pretty good news: long-run jobs created roughly equal to jobs lost, and so on. Is this a question of poor public relations by the researchers? Or is it a question of risk discounting; that workers can see the job losses as fairly automatic; the job gains are there on paper, but something has to be done to create jobs either by the private sector or maybe by the government, that is, government policy to ensure that jobs will exist, or to speed up the creation of jobs which simulation models or research show are there to be had. I have to ask, what is the link between the trade policy or the trade negotiations and the domestic job programs that are going to have to be in place as the tariff or nontariff barriers come down?

MR. BLACKMAN: May I have a volunteer?

MR. BALDWIN: I am afraid that the people in the labor movement just don't believe those studies are accurate. The studies show aggregative job effects to be small. They do show there are some losses in particular industries, and they do show some industries gain; but I think labor feels that, based on their experience of the last several years, that those studies are much too optimistic. They believe there would be severe hardship with tariff cuts. That is the way I read them.

MR. LAMAR: Well, I would like to comment. I could be wrong, but in reading most of these studies, I see that the job impact estimates are discounted in terms of the normal job losses that take place through retirements or quits, and so forth; so that the net impact is estimated in those terms. This approach ignores the continuing stream of job opportunities that a particular industry should be able to offer in maintaining its place in the economy. I think that the labor unions naturally look at these problems in terms of the job opportunities they can offer their members over a period of time. Even if there is a gradual decline in the size of the industry as people are retiring or just leaving the industry, that is not a very satisfactory result from their viewpoint and therefore, there is some dissatisfaction with these types of analyses of trade flows and jobs.

MR. YEUTTER: Well, I think it all goes a little deeper, too, though far be it for me to speak for the labor movement! I hope they don't all faint, now!

But it seems to me that adjustment assistance, or just simple adjustment, is not a very happy alternative for anybody anytime. Labor union leadership is bound to hear from its members if and when their jobs go down the drain. People don't like to be out of work, and they don't like to adjust to something else. They don't really want to partake in adjustment assistance programs and figure out a way to retrain and go elsewhere. They would much prefer to stay right where they are, whether their industry is competitive or not. So the people who represent labor are inevitably going to feel those pressures; and they are going to enunciate those pressures. That is their job. Adjustment is a painful and traumatic process, and one that doesn't come happily to people in the business.

On the export side, which is the counterpoint to that, one never knows for sure whether increased jobs are really going to materialize, or if they do whether they will last. Obviously there are jobs associated with exports, just as there are jobs involved with imports; but there is a fear, often legitimate, that if we begin to penetrate other markets around the world with exports, somebody is going to shut them off; that you will see a response by the importing countries. If, for example, the country is an LDC, and gets into balance of payments problems, it may slap on quotas, like Brazil has done in recent months, and cut out our exports. Or, if it is a developed country, it may figure out some way to use administrative mechanisms to hold down imports. If so, eventually those gains that we have on the export side will be dissipated. We will then be left with the worst of all worlds where imports have increased, and we have gone through the adjustment of trying to live with those, and exports have increased temporarily, but that hasn't lasted. So why go through the exercise, some would argue if you are going to end up losing. Now, it may not always work out that way. Hopefully, it would not work out that way; but one can certainly understand the trepidation that is involved in the union movement.

MR. BLACKMAN: Other questions?

MR. HASSON: My name is Joseph Hasson, Howard University. It seems to me that in the research that has been reported, import elasticities and other estimated coefficients have been extensively used in estimating what the effect of tariff reduction would be. Those coefficients are derived largely on the basis of historical information. And the title of this panel is, "What Value Does Economic Research Have for Trade Negotiations?" I wonder if it is pertinent to ask: isn't it quite likely that the value of those coefficients, say after a tariff cut, will be different than those used in the research that has been reported? And if so, how do we deal with the problem?

MR. BALDWIN: Well, I don't know why they should differ. They are based on price series, historical information which you can take at different times over the past. You can test to see if the coefficients are changing. There may be some trends in certain cases. You measure something over five or ten years, and then another five or ten years; if you see that it is changing, and you have some reason to believe it will continue to change, you project the trend. I would think demand elasticities over the relevant range would not change simply because tariffs changed.

MR. YEUTTER: Bob, I would disagree to at least some degree. I don't think they will change a whole lot in what I would call "basic products," wheat, corn, steel, or something of this nature. But when one goes beyond that, the product mix — and the products themselves — change so much as the world changes. Technology is adjusting so rapidly; and what we are selling today is not going to be the same thing that we sold five years ago. The whole structure of international trade is changing so rapidly that many elasticity estimates are out of date.

In addition to this, a lot of them will change due to increased knowledge around the world of purchase opportunities. More and more we are communicating better than we have in the past, we are selling more aggressively, and so is everybody else in the world. All of those efforts are going to have an impact on export and import elasticity; so I really think many of them will change over time.

MS. JAGER: I think it would be better if we had somebody represent the labor viewpoint from the labor unions rather than having the panelists tell us about what we are about.

MR. YEUTTER: Sorry about that, Liz.

MS. JAGER: I think the question from the young man was an interesting one: Why aren't the labor unions concerned about jobs in exports? Unions believe that everyone knows that union members and the unions who represent them are concerned about jobs in exports. But it was clear from the answers that jobs in exports do not make up for job losses in imports and that jobs in exports exist only so long as other countries don't decide to take action to protect themselves. Other countries start with many protections and, as Ambassador Yeutter pointed out, may add more, so that jobs in exports do not necessarily result from the reduction in negotiated tariffs. Harry Lamar's response was quite accurate.

However, all three spokesmen, almost without thinking, fell into the mythical concept of labor's interest in trade — they sound as if it were a "special" interest — not a general one. Partly that is built into basic international trade theory, where labor is a sector — with a few harmed by trade in the short run but all helped in the long run. Most textbooks implant that view. But the labor unions in the United States have shown a much broader interest. When the AFL-CIO goes before the Congress of the United States, it does not ask just for jobs for its members. It supports the growth and strength of the U.S. economy and jobs for American workers generally. We want jobs not just for steelworkers and machinists, our members; but for workers generally. We want jobs not just for our members, but we want our members to have jobs. In some instances where we have spoken the loudest and the longest, the unemployed have very often been people who are not members of labor unions. Most of the people who lost their jobs through the Mexican border problem were not labor union members — at the beginning. There were no other spokesmen for them. The unions speak for American labor and seek a strong economy for the nation as a whole. The implication that they have worked exclusively as a special interest, while all the trade theorists and others who oppose our views are working for the general interest, is not only unrealistic, it is prejudicial to a fair hearing for our experience and our viewpoint.

MR. BLACKMAN: Thank you, Liz. Thank you, panel.

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